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Volume 1, Number 3
Abstracts 3000-4485

March 1976

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SCOTT, C.D., See JOLLEY, R.L., 75:847
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SYNTHANE PROCESS
COAL GASIFICATION/BI-GAS PROCESS
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Terrestrial photovoltaic power systems with sunlight concentration. Quarterly porgress report, July 1, 1974--September 30, 1974, 75:00737 (NSF-RA/N--74-129)
THERMO ELECTRON CORP., WALTHAM, MASS. (USA)
Advanced thermionic technology, FY1975. Progress report number 4, October 1974, 75:00821 (TE--4190-57-75)
TYCO LABS., INC., WALTHAM, MASS. (USA)
Continuous silicon solar cells. Third quarter progress report, July 1, 1974--September 30, 1974, 75:00742 (NSF-RA/N--74-139)
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ERDA ENERGY RESEARCH ABSTRACTS

COAL AND COAL PRODUCTS

3000 (IS-ICP—2) **Iowa Coal Research Project interim report.** (Iowa State Univ. of Science and Technology, Ames (USA). Energy and Mineral Resources Research Inst.). 15 Jul 1975. 110p. Dep. NTIS $5.25.

The Iowa Coal Research Project is funded by the Legislature for a three-year period beginning July 1, 1974. It is administerd by the Energy and Mineral Resources Research Institute (EMRRI) at Iowa State University. The legislative act calls for EMRRI to carry out research to determine whether Iowa coal can be mined economically and in an environmentally acceptable manner and to investigate and demonstrate methods for improving the quality of Iowa coal by removal of the impurities. The research includes the study of the economics of coal production and transportation, investigation and development of new exploration methods, demonstration of improved land restoration techniques, and investigation of other potentially useful by-products that might be produced as a part of the coal mining operation. (auth)

3001 (MERC/SP—75/2) **Publications on coal and petroleum research at the Morgantown Energy Research Center, 1947—1974.** (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 1975. 102p. MERC.

The list of references is divided into the following main groups: coal, petroleum, miscellaneous, and West Virginia University theses. The coal section is divided as follows: sampling, analyzing, and testing; cleaning, pulverizing, and drying; feeding and transportation; carbonization; combustion and power generation; gasification and synthesis processes; and gas and dust analysis, purification, and processing. The petroleum section is divided as follows: composition and properties of reservoir rocks and fluids; drilling, completing, and reconditioning wells; engineering studies of oil and gas fields; and well and reservoir performance and production techniques. Subject and author indexes are provided. There are 437 citations in the coal section, 186 citations in the petroleum section, 55 citations in the miscellaneous section, and 34 thesis titles in the last section. (EJH)

3002 (ORNL-TM—5092) **Coal technology program progress report for August 1975.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 41p. Dep. NTIS $4.00.

This report, the thirteenth of a series, is a compendium of monthly progress reports for the ORNL research and development projects that are in support of the increased utilization of coal as a source of clean energy. The projects reported this month include those for hydrocarbonization, solid-liquid separations, chemical research and development, analytical chemistry, engineering evaluations of nuclear process heat for coal conversion, coal-fueled MIUS, engineering evaluations of the Hydrocarbonization and Synthoil processes, and biomedical and environmental research. (auth)

3003 (ORNL-TM—5124) **Coal technology program progress report for September 1975.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 25p. Dep. NTIS $4.00.

This report, the fourteenth of a series, is a compendium of monthly progress reports for the ORNL research and development projects that are in support of the increased utilization of coal as a source of clean energy. The projects reported this month include those for hydrocarbonization, solid-liquid separations, chemical research and development, analytical chemistry, engineering evaluations of nuclear process heat for coal conversion, coal-fueled MIUS, and engineering evaluations of the Hydrocarbonization and Synthoil processes. (auth)

PROCESSING

CARBONIZATION

3004 (CONF-751107—1) **Evaluation of current process technology in coal carbonization and hydrocarbonization.** Holmes, J.M.; Cochran, H.D. Jr.; Edwards, M.S.; Joy, D.S.; Lantz, P.M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 30p. Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

It has been shown that a number of processes for carbonization and hydrocarbonization of bituminous coals are available but only one, the Lurgi-Ruhrgas process, has been developed to a commercial stage at the present time. The others are in various stages of development including the Coalcon process which is being designed as a demonstration plant. A wide range of yields can be obtained by these processes which are primarily dependent upon coal rank and process operating conditions. Agglomeration of the coal during carbonization can be prevented by a variety of methods; the most attractive one appears to be the bed recirculation method. Finally, desulfurization of the liquid and char products can be achieved by additional treatment with hydrogen but in the case of the char, beneficiation of the feed coal will probably be necessary. (auth)

DESULFURIZATION AND PURIFICATION

3005 (FE—2033-5) **Hot low Btu producer gas desulfurization in fixed bed of iron oxide fly-ash. Quarterly report No. 1, 1 July—30 September 1975.** Gussow, S.; Mitchell, M.M. Jr. (Air Products and Chemicals, Inc., Marcus Hook, Pa. (USA)). 3 Dec 1975. Contract E(49-18)2033. 17p. Dep. NTIS $4.50.

This is the first quarterly progress report of the APCI support program to assist ERDA in the development of their hot producer gas desulfurization process. An iron oxide-fly ash absorbent will be used in a cyclic fixed-bed operation. Specific objectives of APCI are absorbent development, definition of process scale-up criteria, and commercial process design. Major emphasis this period has been in planning details for Task I, Absorbent Development, and Task II, Model Confirmation, and modifying and repairing the existing ERDA pressure reactor assembly. Absorbent preparation will begin in October 1975. Dynamic absorption tests of these materials are expected to begin in November 1975 in the repaired reactor assembly. (auth)

GASIFICATION

3006 (ANL—75-39) **Chemical Engineering Division. Coal technology semiannual report, January—June 1975.** Fischer, J.; Che, S.; Lo, R.; Nandi, S.; Young, J.; Jonke, A. (Argonne National Lab., Ill. (USA)). Jul 1975. Contract W-31-109-Eng-38. 29p. Dep. NTIS $4.00.

This effort, which is part of the Argonne National Laboratory energy program for ERDA, was started in September 1974 to conduct research and development in process chemistry and engineering in support of projects on coal conversion into clean fuels. The first effort is being directed toward improving coal gasification processes. Specific tasks in process technology were selected for supportive work for the national endeavor on it situ

coal gasification. This initial effort is aimed toward solving problems in the in situ coal gasification process being developed at Lawrence Livermore Laboratory (LLL). The effort is also aimed toward gaining insight into the mechanisms involved in coal gasification reactions, so that improved techniques, processes, or catalysts can be developed. Three tasks were chosen for initial investigation; these include work on improved char utilization, an investigation of improved char gasification and catalytic processes for coal conversion, and a study of the catalytic activity of coal ash. (auth)

3007 (FE—415-T2) **Consol lignite gasification process development. Monthly progress reports for the period January—December 1965.** (Consolidation Coal Co., Library, Pa. (USA)). [nd]. Contract 14-01-0001-415. 90p. Dep. NTIS $7.50.

The feasibility study was completed and reported during the first month of the reporting period. The remainder of the period was devoted to bench-scale work including batch kinetic studies and operation of the continuous gasification unit. (EJH)

3008 (FE—415-T3) **Consol lignite gasification process development. Monthly progress reports for the period January—December 1966.** (Consolidation Coal Co., Library, Pa. (USA)). [nd]. Contract 14-01-0001-415. 135p. Dep. NTIS $9.75.

Bench-scale work was continued throughout the period, and the process design effort on the pilot plant was started. The cumulated expense through the reporting period was below the budget figure. (EJH)

3009 (FE—1207-1) **Gas generator research and development: BI-GAS process. Annual report, June 1974—June 1975.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 1 Aug 1975. Contract E(49-18)-1207. vp. Dep. NTIS $7.60.

Bench-scale tests during the year included life tests of several experimental methanation fluidized-bed catalysts to determine their applicability for use in the methanation process and equipment development unit (PEDU). Promising catalysts were then tested in the bench-scale methanator (BSM) and in the cold flow model to obtain operating parameters prior to the PEDU tests. Methanation PEDU Test 8 through 15 were conducted during the year. Catalyst BCR Lot No. 3234, a molybdenum on alumina catalyst, was used in Test No. 8. During the 10-day test, conversions between 60 and 90 percent were obtained, depending upon conditions. Test No. 9 and 10 were ended prematurely because of equipment problems. Test No. 11 through 15 were made with the same catalyst, BCR Lot No. 3256, a nickel-cobalt on silica-alumina catalyst. After 21 cumulative days of testing, the activity of the catalyst remained at a high level, converting 80 to 90 percent of the ($CO + H_2$). (auth)

3010 (FE—1527-1) **Gas generator research and development: clean fuel gas. Annual report for the period June 1974—June 1975.** (Bituminous Coal Research, Inc., Monroeville, Pa. (USA)). 8 Aug 1975. Contract E(49-18)-1527. 65p. Dep. NTIS $5.45.

Construction of the fluidized-bed gasification process and equipment development unit (PEDU) by Blaw-Knox Chemical Plants Division of Dravo Corporation is 99 percent. Laboratory work during the year consisted of the construction of a plastic cold model of the first-stage reactor of the PEDU. Tests were made to determine fluidization characteristics and the effect of coal particle size on bed expansion. Results of the tests showed that: (1) a new distributor design is required to obtain complete fluidization of the bed; and (2) better agreement was obtained with the mathematical formulation described by the maximum stable bubble-size model than with the uninhibited growth model, at least for the smaller particles. A predictive model was developed for conversion in Stage 2 of the fluidized-bed gasifier. The equations are being programmed for solution. (auth)

3011 (FE—1767-T1) **Mixing and gasification of coal in entrained flow systems. Quarterly report for the period 29 November 1974—31 March 1975.** Smoot, L.D.; Hanks, R.W. (Brigham Young Univ., Provo, Utah (USA). Dept. of Chemical Engineering). 1975. Contract E(49-18)-1767. 88p. Dep. NTIS $5.45.

Work on the investigation of the effects of the mixing process on coal gasification kinetics is presented. From a review of the literature and technical visits, typical operating conditions for coal gasification were identified. The effects of composition and pressure on the heating value of gasified coal/oxygen/steam mixtures was conducted using a thermochemical equilibrium program. Test conditions were also designed. Variables in the test program include percent steam, coal loading level, pressure, secondary injection angle, coal type, and particle size. Design of the high-pressure facility was initiated. A test program for atmospheric, nonreactive, jet mixing tests was also outlined and the first test was conducted using an available test facility. (auth)

3012 (ORNL—5069) **Coal technology program. Annual interim report for fiscal year ending June 30, 1975.** (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 115p. Dep. NTIS $5.45.

In hydrocarbonization research, the review and evaluation of existing process technology was completed. Experimental development work, using ambient mock-ups, has been conducted to evaluate the performance of a recirculating fluidized-bed reactor, a coal feeder, a flowmeter for coal, solids withdrawal, and cyclones. A review and evaluation of available data in solid-liquid separations was completed followed by scouting tests in agglomeration, settling, centrifugation, filtration, and solvent fractionation of SRC and COED unfiltered oils. Experimental simulation of the in-situ gasification process was conducted. Pyrolysis experiments with maximum temperatures of 1000°C were performed with large instrumented blocks of subbituminous coal. It was concluded that volatilization of water is the heat-transfer-rate-limiting mechanism and that high-temperature pyrolysis reactions are decidedly exothermic. In the project for systems studies of coal production, hypothetical mine models are being constructed. Work continues in the engineering evaluations of the Synthoil and Hydrocarbonization processes. In the engineering evaluations of nuclear process heat from coal conversion, United Engineers and Constructors, Inc., made a study of the use of very-high-temperature nuclear reactors (VHTRs) for process heat applications. Some conclusions of the study are that the Hy-Gas process is lessexpensive for production of synthetic pipeline gas. The General Atomic/Stone and Webster (GA/S and W) process using nuclear heat is competitive to the Lurgi process. Depending on coal costs, GA/S and W may be competitive to the Koppers-Totzek plant. (EJH)

3013 (SAND—75-0471) **Attenuation of acoustic compressional waves in coal and shale at Hanna, Wyoming.** Stearns, S.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 18p. Dep. NTIS $4.00.

Acoustic data from explosive shot tests at Hanna, Wyoming, have been analyzed to produce attenuation estimates. This report describes the experimental setup and analysis methods, presents the attenuation results, and discusses acoustic monitoring of in-situ coal gasification in the light of these results. (auth)

3014 (UCRL—50026-75-2) **LLL in situ coal gasification program. Quarterly progress report, April—June 1975.** Stephens, D.R.; Lentzner, H.L. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Sep 1975. Contract W-7405-Eng-48. 28p. Dep. NTIS $4.00.

The conversion of coal into a clean combustible gas can permit environmentally sound utilization of the principal fossil resource. If the conversion is accomplished with the coal in place underground (in situ gasification), there are additional environmental and economic advantages. In its most elementary form, coal gasification consists of the partial oxidation of coal to form a combustible mixture of gases; the coal is simply heated in the presence of gasifying agents such as oxygen and steam. If an efficient and economic process is to be achieved, however, a multitude of chemical, physical, and geological factors must be properly controlled. A new approach to in situ coal gasification was originated at the Lawrence Livermore Laboratory (LLL) in 1972, and a program aimed at evaluating the concept was initiated. The LLL concept is designed to provide high-Btu gas (comparable in energy content to natural gas) from the thick, deep, coal deposits prevalent in the western United States. The product gas, after treatment in a surface facility, would have sufficiently high energy density to make distribution through existing pipelines economically attractive. (auth)

3015 (UCRL—50026-75-3) **LLL in situ coal gasification program. Quarterly progress report, July—September 1975.** Stephens, D.R.; Schneider, C.R. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. Contract W-7405-Eng-48. 37p. Dep. NTIS $4.00.

The LLL concept is designed to provide high-Btu gas (comparable in energy content to natural gas) from the thick, deep, coal deposits prevalent in the western U.S. The product gas, after treatment in a surface facility, would have sufficiently high energy density to make distribution through existing pipelines economically attractive. It is believed that, when compared with conventional mining followed by surface gasification, the proposed in situ gasification method has the following potential advantages: a reduced cost for synthetic natural gas, less environmental damage, an absence of hazards to miners, and economic access to deep western coals. (auth)

3016 (UCRL—51904) **In situ gasification of softening coal.** Wong, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Sep 1975. Contract W-7405-Eng-48. 10p. Dep. NTIS $4.00.

The design of in situ gasification systems for coals that soften on heating is considered. It is shown that these coals will not support open channels against overburden pressure for any significant length of time. Thus, the zones of heated and softened coal must be localized. This study is applicable to some subbituminous as well as bituminous coals. A workable gasification system for these coals would involve flow through widely spaced channels typical of the Soviet gasification systems. To determine how widely spaced the channels should be, the heat wave propagation depth from the channel into the coal must first be calculated. It is shown that if the coal surface in the reaction zone is burning at 1 m/d, heat is carried by conduction only 30 mm into the coal. This limited conductive heat propagation explains why reverse combustion processes tend to create narrow channels. However, downstream of the reaction zone, channel heating by product gases can propagate into the coal. For the typical Soviet line-drive system, heating will propagate to a depth no more than 18 percent of the distance between channels as the gasification of a section is completed. Hence, channel closing caused by coal softening has only a small effect in this system. (auth)

3017 (UCRL—51909) **High explosive fracturing studies in coal.** Hearst, J.R.; Larson, D.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1975. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

In situ coal gasification using chemical high explosives to fracture coal at depth is described. The one-dimensional Lagrangian elastic-plastic brittle-failure computer program SOC is used to compute ϵ/sub f/, the total failure-induced shear strain, for coal. ϵ/sub f/ is then associated with shot-induced fracture in coal and the corresponding permeability change. In laboratory experiments permeability was measured as a function of radius from the shot, postshot. Epoxy was injected into the shot hole, the coal sectioned, and the observed cracks compared with calculations. The shot-induced cavity radius agreed well with the calculated value. The radius for major changes in appearance of the coal corresponded to an ϵ/sub f/ of about 0.05, and the epoxy-filled fracture radius to about 0.02. Permeability data are questionable, but significant increases were observed to an ϵ/sub f/ of 0.005. The primary measurements in the field experiment were preshot and postshot permeability, preshot and postshot fracture frequency in cores, acoustic velocity as a function of depth, penetration of dye from the shot hole, ease of drilling post-shot holes, attenuation of acoustic waves pasing through the shot region, and electrical resistivity and attenuation of electrical signals passing through the shot region. All of these measurements were made as a function of radius. Increased permeability, increased fracturing, increased acoustic attenuation, decreased sound speed, easier drilling, and dye from the shot hole were found within a radius corresponding to an ϵ/sub f/ of about 0.01. Laboratory and field experiments were found to agree within measurement uncertainty, and it appears that calculated ϵ/sub f/ can be associated with shot-induced effects within reasonable error. (auth)

3018 (UCRL—52000-75-9, pp 9-13) **Methanol from in situ coal gasification.** Sep 1975.

In Lawrence Livermore Laboratory energy and technology review.

Methanol (methyl alcohol) is a convenient way to use coal as a fuel in internal combustion engines and thus move toward self-sufficiency in the transportation sector. The production route is conversion of coal to synthesis gas (carbon monoxide and hydrogen), which is converted catalytically under high pressure to methanol. The enabling technology may be in situ coal gasification: cheaper than conventional mining and surface gasification, with less environmental impact and the capability for exploiting deep coal seams that cannot be mined economically. For in situ gasification, the capital requirements are estimated to be $354 million (1974 dollars) for a 13,600-tonne-per-day methanol plant. In terms of energy output, this corresponds to 85,500 TJ (81 trillion Btu) annually. Projected plant or refinery costs are $0.99 per GJ ($1.04 per million Btu): 5.9 cents per gallon or 1.6 cents per litre. Adding distribution costs and taxes, we calculate a delivered pump price that is economically competitive with gasoline. (auth)

3019 (UCRL-Trans—10933) **Underground gasification of coal.** Slokan, K. Translated from *Nova Proizvod.*; 5: No. 1, 14-25(1954). 32p. Dep. NTIS $5.00.

The problem of underground gasification has attracted attention in many countries, sometimes approaching close to a solution, and every country possessing major coal reserves is spending large sums on this important problem. The experience in individual countries is discussed. At its latest meeting the Conference of Mining Engineers and Technicians in Slovenia has debated the necessity of beginning, in that country as well, to resolve the substantial losses occurring during the winning of coal, which amount to more than a million tons. (auth)

3020 (UCRL-Trans—10922) **Underground gasification of the Angren brown-coal field.** Lavrov, N.V.; Kulakova, M.A.; Kazachkova, S.Ts.; Zhirnyi, A.E.; Antonova, R.I.; Volk, A.F. Translated from *Khim. Tverd. Topl.*; No. 1, 73-79(1971). 16p. Dep. NTIS $4.50.

The experience of operation of underground gas generators at the Angren station is generalized. The influence of blast intensity for various seam thicknesses, specific gasification of the coal, and seam flooding on the indicators of the gasification process, duration of operation of holes of various types, process efficiency, and the technical and economic aspects are analyzed. (auth)

3021 (UCRL-Trans—10958) **Principal results of experimental work on the underground gasification of brown coal in the USSR.** Skafa, P.V. Oct 1975. Translation of Paper 33, Section B2, of world power conference, Belgrade, Yugoslavia, June 1957. 34p. Dep. NTIS $5.00.

A continuous method of gasifying a coal seam in a canal, in which artificial crushing of the seam and penetration of the seam with a dense network of boreholes are not required, has been worked out in the USSR as a result of experimental work on the underground gasification of coal. Methods of opening a coal seam with vertical, inclined, and curvilinear boreholes that do not require shafts have been developed. A number of methods of cutting gasification canals through seam-opening boreholes have been worked out. The production of producer gas has been mastered on an industrial scale, and the first experimental data concerning the possibility of producing process gas have been obtained. The current technical level of the underground gasification of coal achieved in the USSR makes it possible to recommend underground gasification for the exploitation of appropriate coal fields or sectors with a view to generating producer gas that has technical and economic indices surpassing those of mined coal. The technical and economic indices that have been achieved in the underground gasification of coals undoubtedly will be greatly improved in the future with the development of the engineering techniques, which are newer than those of other methods of coal mining and contain tremendous potential. (auth)

3022 (UCRL-Trans—10957) **Kinetics of coke gasification.** Foerster, E.; Friedrichs, H.A.; Liebisch, P.; Schierlo, U. Oct 1975. Translated from pp 78-83 of Novye Metody Issledovaniya Protsessov Vosstanovleniya Tsvetnykh Metallov, Doklady na Simpoziume (Symposium papers), No. 1-5, 1971. 10p. Dep. NTIS $4.50.

A mathematical model of the blast furnace process has been worked out in recent years by a number of metallurgical enterprises and higher educational institutions with the assistance of the German metallurgists union. The necessity of investigating in greater detail, theoretically and experimentally, the problem of coke gasification was elucidated within the framework of this major project, insofar as previous knowledge proved inadequate to explain the phenomena observed in coke beds. Consideration of this complex problem presupposes the adoption of a rather idealized model. This model stems from a differentiated coke bed having a thickness dx, whose rate of gasification is determined as a function of the grain size and of the composition, temperature, and velocity of the gas. This problem can be formally reduced to the consideration of one piece of coke taken separately, provided that the real relations of mass transfer and heat transfer that obtain in the bed are taken into account. The behavior of the entire differetiated bed then will consist of the sum of the properties of the individual pieces of coke. (auth)

LIQUEFACTION

3023 (BERC/RI—75/12) **Analyzing syncrude from western Kentucky coal.** Sturm, G.P. Jr.; Woodward, P.W.; Vogh, J.W.; Holmes, S.A.; Dooley, J.E. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Nov 1975. 31p. Dep. NTIS $4.00.

A synthetic crude oil derived from western Kentucky coal by the charoil-energy development (COED) process was separated into two distillates and a residuum fraction. The lower boiling distillate was further separated by chemical extractions and chromatography and was characterized by gas chromatography and spectral techniques. The higher boiling distillate and the residuum were further separated and characterized largely by methods developed by the ERDA Energy Research Centers in Bartlesville, Okla., and Laramie, Wyo., for characterization of heavy ends of petroleum. By adsorption chromatography the higher boiling distillate and residuum were separated into four concentrates: saturates, monoaromatics, diaromatics, and polyaromatic-polar. The saturate concentrates were characterized directly by mass spectrometry. The monoaromatic and diaromatic concentrates were further separated by gel permeation chromatography (GPC) before characterization by GPC-mass spectral correlations and nuclear

magnetic resonance (NMR) spectrometry. After acid and base extractions the polyaromatic-polar concentrates were characterized in the same manner as the monoaromatics and diaromatics. Mass spectrometry was used to qualitatively analyze the acid and base extracts. Physical and chemical properties obtained by the Energy Research and Development Administration routine crude oil analysis procedures complete the characterization data which are valuable for determining appropriate and efficient refining processes. The results obtained were similar to those for the Utah syncrude that was characterized by ERDA in a previous study and showed the syncrudes contained hydrocarbon types similar to those found in petroleum crudes. However, the syncrudes were more aromatic in character with substitution of shorter alkyl groups on the aromatic rings. They also contained appreciable amounts of oxygenates and had a fairly uniform distribution of nitrogen compounds across the boiling range. (auth)

3024 (FE—0497-2) **Coal conversion processes. Part II. Assessment of multienergy product processes utilizing coed char, oil and gas. Interim report No. 5 for period August 1974—Gebruary 1975.** Wen, C.Y.; Lin, C.Y.; Negru, G.; Daugherty, D.; Li, C.; McMichael, W.J. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). Nov 1975. Contract E(49-18)-0497. 152p. Dep. NTIS $7.60.

Several alternatives for utilizing COED oil, gas, and char to produce synthetic crude oil, pipeline gas, methanol, and electricity have been considered in this report. These alternatives have been designed to be self-sustaining in that power and steam required in these alternatives are produced via COED char gasification. A comparison of the energy conversion efficiencies for producing the various energy products in different alternatives has been made. The capital investment, annual operating expenses, and revenue requirement, as well as the product cost for processing coal at a rate of 8 million tons per year by the various processes, are estimated. The sensitivity of the various energy product costs to changes in the overall carbon conversion in the processes, to changes in the coal price, stream factor, installed equipment cost, operational labor cost, and the rate of return on investment are also considered in this study. (auth)

3025 (ORNL-TM—4777, pp 218-234) **Coal conversion process development.** Jul 1975.

In Experimental Engineering Section semiannual progress report.

The coal conversion program is a relatively new effort directed initially at characterization of liquids and gases from coal conversion processes, bench-scale studies of hydrocarbonization, evaluations of techniques for removing solids from coal-derived liquids, and development of methods for removing H_2S from coal gasification products. Initial characterization studies have included liquid chromatography with Dowex 1-, silica-, and alumina-filled columns. Attempts to use a succession of nonpolar solvents resulted in extraneous detector responses. Tests with samples of COED and SYNTHOIL products indicated that the techniques studied thus far will not completely separate all components; however, they could be combined usefully with other fractionations. Gas chromatography studies with several polyaromatic compounds have been made with high-temperature Dexsil packing (up to 350°C), and retention data are reported. Plans for experimental studies of engineering problems of coal conversion have been outlined. Hydrocarbonization studies will include construction and operation of a bench-scale (10- to 20-lb coal/hr) facility capable of operating at temperatures up to 1500°F and pressures up to 150 atm. A variety of filtration, agglomeration, and centrifugal techniques for removing solids from liquefaction products will be tested. Liquid products from OCR liquefaction pilot plants, and eventually from ORNL hydrocarbonization studies, will be used. High-temperature methods for removing H_2S from coal-derived gas streams will be developed. A molten mixture of carbonate salts appears to be promising for sorbing H_2S at high temperatures. (auth)

3026 (ORNL-TM—4968) **Supporting research and development on separations technology. Phase II report: scouting experiments.** Rodgers, B.R.; Katz, S. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 145p. Dep. NTIS $7.60.

This report describes the second phase of a project, sponsored by the Energy Research and Development Administration, Division of Fossil Energy, that has the objective of developing methods for accomplishing solid-liquid separations that are required for coal liquefaction processes. The first phase was a review and evaluation of available data and the formation of a plan for laboratory experiments. Phase II has consisted of characterization tests of COED and SRC process streams, and scouting tests for some alternative separation methods. A third phase will initiate bench-scale development of solvent fractionation-dilution, advanced filtrations, and continuation of the characterization tests. (auth)

PYROLYSIS AND CRACKING

3027 (CONF-750859—2) **Reactivity of coal and char in CO_2 atmosphere.** Dutta, S.; Wen, C.Y.; Belt, R.J. (West Virginia Univ., Morgantown (USA). Dept. of Chemical Engineering). 1975. 12p. Dep. NTIS $4.50.

From Fall meeting of the American Chemical Society; Chicago, Illinois, USA (24 Aug 1975).

Reactivities of a few raw coals and chars of these coals obtained from gasifiers operating under different conditions were measured in CO_2 at the temperatures 1550 to 2000°F. The reactivities were measured in a thermogravimetric analyzer up to complete conversions of the samples in most cases. Properties like surface area pore size distribution, porosity and density have been determined for each sample. Actual pore structures of a few samples have been observed at different conversion levels by a scanning electron microscope. In order to compare the reactivities of different samples, the char-gasification process was divided into two distinct stages: the first stage due to pyrolysis and the second stage due to char-CO_2 reaction. Reactivities due to the first stage can be roughly related to volatile matter contents of the solids and the rate of heating. Through an Arrhenius type equation, an activation energy of about 2.5 Kcal/mole is obtained for the first stage. The reactivity of a char in the second stage is found to depend more on its coal seam than on the gasification scheme used in its production. Activation energy for the second stage reaction has been found to be about 59 Kcal/mole. A rate equation has been proposed for the second stage that incorporates the effect of relative available pore surface area changing during reaction. The rate conversion curves calculated from this equation fit well with the experimental data. (auth)

3028 (UCRL-Trans—10952) **Thermal stability of the primary products of the coking of coal.** Sukhorukov, V.I.; Bezdvernyi, G.N. Translated from *Khim. Tverd. Topl.*; No. 4, 139-142(1974). 10p. Dep. NTIS $4.50.

A study was made of the thermal stability of the vaporous and gaseous semicoking products and primary tar of the Kizel and Kuznetsk coals found in the charge of the Gubakha Coke By-Product Plant. The dependence of the thermal stability of the vaporous and gaseous semicoking products and of the primary tar on the yield of volatile substances was established. The temperature of pyrolysis is the decisive factor affecting thermal stability. (auth)

SOLVENT EXTRACTION

3029 (FE—496-T4) **Development of a process for producing an ashless, low-sulfur fuel from coal. Volume II. Laboratory studies. Part 2. Continuous reactor experiments using anthracene oil solvent. R and D report No. 53, interim report No. 7. Period covered: October 1970—November 1972.** Wright, C.H.; Pastor, G.R.; Perrussel, R.E. (Pittsburg and Midway Coal Mining Co., Merriam, Kans. (USA)). Sep 1975. Contract E(49-18)-496. 277p. Dep. NTIS $7.60.

A summary of the work done to develop a continuous laboratory reactor system to study solvent refining of coal is presented. A description is included of the evolution of the continuous reactor system and of the analytical methods developed to support the studies done. As a result of this work apparatus and operating procedures were devised that allowed accurate closure of material balances and of most elemental balances involved in the study of this process. Studies were done with a bituminous coal, a lignite coal, and a subbituminous coal, each chosen to represent a typical coal within the ranks represented. Pure hydrogen, carbon monoxide, and carbon monoxide-hydrogen mixtures were considered as reducing gases for each coal. Raw anthracene oil and two different lots of partly hydrogenated anthracene oil were used as solvent in these studies. (auth)

PROPERTIES

3030 (PERC/RI—75/4) **Detection of organic compounds in respirable dust.** Shultz, J.L.; Friedel, R.A.; Sharkey, A.G. Jr. (Energy Research and Development Administration, Pittsburgh, Pa. (USA). Pittsburgh Energy Research Center). Oct 1975. 39p. Dep. NTIS $4.00.

High-resolution mass spectrometry was used to analyze the organic material in respiratory-size coal dust (prepared) and mine dust (collected in coal mines). The objective was to identify and classify the organic compounds in respirable mine dust obtained from mining regions of high- and low-incidence of coal workers' pneumoconiosis (CWP). Analyses of organic material from mine dust and raw coal samples collected in mines having both low- and high-incidence of pneumoconiosis, from various rank coals, and

from different geographic areas were compared. Mass spectral data were obtained for 21 respirable mine dusts and six respirable-size (3.3 to 5.5 μ) coal dusts. From these data the structural types of the hydrocarbons and the carbon number distributions of the organic components were determined and the distribution of the aromatic ring systems, type of ring condensation, and degree of alkylation of the aromatic rings were calculated. The mass spectral data correlate well with the ranks of the coal seams studied. While a direct correlation could not be established between the incidence of CWP and types of hydrocarbons detected in the 21 mine dusts investigated, the composition of the organic material is different for coals from regions of high-, medium-, and low-incidence of CWP. A highly saturated hydrocarbon contaminant was detected in many of the mine dusts, possibly a lubricant from mining machinery. (auth)

3031 (UCRL-Trans—10921) **Predicting the explosive properties of coal dust.** Lysenkov, P.A. Translated from *Zap. Leningrad. Gorn. Inst.*; **55**: No. 1, 72-74(1968). 7p. Dep. NTIS $4.50.

One of the principal factors characterizing the tendency of coal dust to explode is the release of volatiles, and in some cases this is regarded as determining the degree of explosiveness of the dust. The present work is interpreted as showing that explosiveness in the first period of oxidation is slightly increased after which it is lowered, the increase apparently being due to the sorption of oxygen by the coal, formation of peroxides, and lowering of the ignition temperature. With an increasing degree of oxidation, in spite of the fact that the total amount of volatiles becomes greater, the proportion of their fuel component decreases and there is an increase in the ballast volatiles, which reduces the explosiveness of the dust. (EJH)

3032 (UCRL-Trans—10956) **Influence of thermal degradation time on the properties of coal in the plastic state.** Geguchadze, R.A. Translated from *Tr. Inst. Goryuch. Iskop., Moscow;* **27**: No. 2, 26-38(1972). 16p. Dep. NTIS $4.50.

A rheological study was made of coals having different caking capacity at temperatures of 410, 425, 430, 435, and 440°C as a function of different residence times in the plastic state. Certain general regularities and changes in the plastic coal mass were detected. The plastic coal mass obtained from coals having different caking capacity is characterized by fully defined empirical rheological indices and changes regularly as a function of degradation temperature; the properties of the plastic coal mass are dependent not only on temperature but also on the duration of heat treatment. At different temperatures coal forms a plastic mass of varying viscosity, and the properties and character of the dispersion system obtained at a certain temperature change as a function of the duration of heat treatment. The time necessary for a change in the properties of coal decreases with an increase in heating temperature, and therefore, by changing the temperature, pressure, and holding time, it is possible to impart specific technical properties to the plastic coal mass. (auth)

3033 (UCRL-Trans—10953) **Study of coal from the Novomoskovskii field in the Western Donets Basin.** Taits, E.M.; Bronovets, T.M.; Kuzyaev, L.S.; Andreeva, I.A. Translated from *Khim. Tverd. Topl.*; No. 3, 3-8(1973). 13p. Dep. NTIS $4.50.

The physical, chemical, and caking properties of coals from seams of the newly exploited sections of the Novomoskovskii field in the Western Donets Basin are investigated. These coals are similar to brown coals in a number of indices, but there also are significant differences due to their complex petrographic composition. The possibility of using them for power and process purposes is described. (auth)

3034 **Studies of e.s.r. linewidths in coals and related materials.** Retcofsky, H.L.; Thompson, G.P.; Raymond, R.; Friedel, R.A. (Pittsburgh Energy Research Center). *Fuel;* **54**: No. 2, 126-128(Apr 1975).

An investigation was carried out to explore the importance of two line-broadening mechanisms which may be responsible for the width of the electron spin resonance signals exhibited by coals. Studies of catalytically dehydrogenated coals, isotopically substituted low-temperature chars, and a large number of vitrains from coals of all ranks support the view that electron—nuclear hyperfine interactions produce significant contributions to the e.s.r. linewidths found for low-rank coals. Anisotropic g-values appear to be relatively unimportant for low-rank coals, but measurements made on oriented sections of young anthracitic coals revealed a small but reproducible anisotropy in the e.s.r. g tensor. (auth)

3035 **High-pressure deformation of coal from Powder River Basin, Wyoming.** Bonner, B.P.; Abey, A.E. (Univ. of California, Livermore). *Fuel;* **54**: No. 3, 165-168(Jul 1975).

Data on the mechanical response of Powder River Basin coal at high pressures are needed to model the fracture properties of coal beds subjected to explosive loading. The pressure-volume relation to 3.0 GPa, and shear-strength v. mean-pressure failure properties, to a confining pressure of 0.7 GPa, are reported. Brittle fracture was found to limit the shear strength of the coal, even at 0.7 GPa. The coal was compressible (22 percent volume strain at 3.0 GPa) with little or no unloading hysteresis. The discontinuous, pressure-induced phase transitions normally associated with free water were not evident in the coal compressions, although water was present. (auth)

3036 **Carbon molecular sieves for the concentration of oxygen from air.** Nandi, S.P.; Walker, P.L. Jr. (Pennsylvania State Univ., University Park). *Fuel;* **54**: No. 3, 169-178(Jul 1975).

The micropore structure of a number of American coals varying in rank from LVB to lignite has been modified by two methods: (1) heat treatment in nitrogen to 800-900°C, and (2) air oxidation near the ignition temperature followed by heat treatment to 900-1000°C in nitrogen. The second method of treatment is a necessity for coking coals. The chars from HVC coal using method (1) and from LVB coal using method (2) showed selective oxygen adsorption from air. Preferential oxygen uptake is attributed to an initial rate of oxygen adsorption that is higher than that for nitrogen owing to molecular sieve structure. Carbons obtained from coconut shells and some highly crosslinked synthetic polymers (for example, polydivinyl benzene) also showed selective oxygen adsorption. Adsorption of both gases on these carbons is primarily physical, that is, adsorption and desorption cycles can be performed by pressure swing with no significant loss of capacity. The slope of the oxygen isotherm is higher than that of the nitrogen isotherm, indicating that oxygen adsorption is enhanced over that of nitrogen at higher pressures. Operating at pressures around 6.3 MPa and 25°C with air, oxygen concentration in the desorption product stream can be increased to about 36 percent. Using three beds of carbon in series, the final product gas can be concentrated to about 80 percent oxygen. The fraction, by volume, of the inlet gas which is realized as product gas depends upon a number of variables. (auth)

3037 **Fluorescence characteristics of thermo-altered exinites (sporinites).** Ting, F.T.C.; Lo, H.B. (Univ. of North Dakota, Grand Forks). *Fuel;* **54**: No. 3, 201-204(Jul 1975).

Fluorescence spectra of heat-treated exinites (sporinites) vary systematically with increasing temperatures of treatment. The wavelength of the fluorescence maximum, lambda/sub max/, shifts toward the longer wavelength as a result of thermal alteration. The maxima shift from 560 nm in untreated lignite to 640 nm in lignite after heating to 350°C. Numerical values, such as fluorescence maximum, lambda/sub max/, and spectral quotient, Q/sub s/ = I_{650}/I_{500}, can be used as rank parameters of coals. The technique can also be used as a tool to monitor thermal reactions of coals at relatively moderate temperatures. The method can distinguish certain resinites from exinites. (auth)

ENVIRONMENTAL ASPECTS

3038 (BERC/RI—75/8) **Emission control for diesels operated underground: catalytic converters.** Marshall, W.F. (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Aug 1975. 12p. Dep. NTIS $4.00.

The Energy Research and Development Administration is conducting a series of experiments for the U.S. Bureau of Mines to determine the influences of emission controls on exhaust emissions from diesel engines. Tests were conducted with engines typical of those used in underground mines using catalysts specifically designed for diesel engines. Results showed marked differences in catalyst efficiencies for reducing carbon monoxide, hydrocarbon, and odor levels. Although catalysts decrease emissions of oxidizable toxicants, they can produce unwanted or hazardous products (for example, SO_3). Subsequent exhaust treatment may be necessary for a complete control system. (auth)

3039 (UCRL—77303) **Comprehensive approach for evaluating the environmental and human health effects of coal-fired electricity production in the southwest.** Ermak, D.L.; Kercher, J.R.; Ritschard, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Oct 1975. Contract W-7405-eng-48. 37p. (CONF-751118—1). Dep. NTIS $5.00.

From Proceedings of disturbed lands reclamation and use in the southwest; Tucson, Arizona, USA (Nov 1975).

The approach developed by the Regional Studies Group at LLL for evaluating the environmental impacts of coal-fired electricity production in the southwestern United States is presented. The electric power generation process is divided into four components: coal mining; coal transportation; electric power genera-

tion; and electric power transmission and each is considered for possible sources of environmental degradation. In the case of pollutants, the possible transport pathways through the environment are identified. Environmental effects are discussed under the headings of: atmospheric; land and soil; hydrospheric; biotic; and human health. For each effect the method and data required for evaluating the magnitude of the effect are stated. The effects that are expected to be most significant are identified. (auth)

MINING

3040 (SAND—75-5672) **Validation of finite element codes as applied in underground mine design.** Tillerson, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 12p. (CONF-751013—6). Dep. NTIS $4.00.

From 12. annual meeting of the Society of Engineering Science; Austin, Texas, USA (21 Oct 1975).

The finite element method has been developed to the point where each of the four types of validation studies can be performed and significant contributions made by the numerical techniques during the design of underground structures. Appropriate examples of validation studies made using finite element codes will be presented. These illustrations will draw upon current work in assessing mine stability in bedded salt formations as well as upon important studies conducted by other analysts. (auth)

COMBUSTION

3041 (ANL/ES-CEN—1012) **Properties of a dolomite bed of a range of particle sizes and shapes at minimum fluidization.** Saxena, S.C.; Vogel, G.J. (Argonne National Lab., Ill. (USA)). Sep 1975. 19p. Dep. NTIS $4.50.

A two-phase model to describe the combustion of coal in a fluidized bed of dolomite would be critically influenced by the properties, at minimum fluidization, of bed materials of a range of particle sizes and shapes. To aid in developing the model, experiments were performed with dolomite particles of a size distribution in the range of about 1410-88 μm in a 6-in.-diameter fluidized-bed reactor. The bed voidage at fluidization and the minimum fluidizing air velocities were determined as a function of temperature (70-800°F) and pressure (26-121 psia). The experimental data suggest that, at a given temperature, the minimum fluidization velocity decreases with increasing pressure and that, at a given pressure, probably, it is independent of temperature. These data were correlated using the Ergun relation. The mean sphericity of the particles required in the Ergun correlation was determined from experimental pressure drop data at low Reynolds number. Other methods often employed for predicting the minimum fluidization velocity of a bed of single-size spherical particles were examined with appropriate modifications for their applicability to a bed consisting of a wide range of particle sizes and shapes. Specific recommendations have been made as to the applicability of the different methods for calculating minimum fluidization velocities. (auth)

3042 (CONF-750616—4) **Potential of fluidized-bed combustion for reducing trace-element emissions.** Swift, W.M.; Vogel, G.J.; Panek, A.F. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 20p. Dep. NTIS $4.00.

From Annual meeting of the air pollution control association; Boston, Massachusetts, USA (16 Jun 1975).

Experiments were performed in a bench-scale, 6-in.-dia, pressurized, fluidized-bed combustor to evaluate the potential of fluidized-bed combustion for reducing trace-element emissions as compared with conventional coal combustion systems. Trace element concentrations of solid materials in the inlet and outlet streams (plus Hg and F concentrations in the flue gas) were measured for the purpose of making mass balances around the experimental unit. Mass balances were made for the following trace and minor elements: Hg, F, Be, Pb, As, Br, Co, Cr, Fe, K, La, Mn, Na, and Sc. Wet chemical techniques were employed to measure the concentrations of the four elements of primary interest in the investigation, Hg, Pb, Be, and F, with the concentrations of the remaining ten elements determined by neutron activation analysis. Overall mass balances for seven of the elements (Pb, Co, Fe, K, La, Na, and Sc) had material balances of 100 +- 10 percent, thereby indicating within analytical accuracy, essentially no losses of these elements by volatilization. Retention of the relatively volatile elements, Hg, F, Br, and As, all indicated a definite potential for fluidized-bed combustion to reduce the emissions of these elements. combustion temperatures of fluidized-bed combustion are apparently effective, however, in reducing the preferential concentration of trace elements in the finer ash particles which has been observed in conventional coal-fired power plants. (auth)

3043 (FE—1787-1) **Modeling of a fluidized bed combustor with immersed tubes. Quarterly report, June—August 1975.** Saxena, S.C.; Rehmat, A.; Grewal, N. (Illinois Univ., Chicago (USA). Dept. of Energy. Engineering; Institute of Gas Technology, Chicago, Ill. (USA)). Aug 1975. Contract E(49-18)-1787. 20p. Dep. NTIS $4.50.

A mathematical model of a fluidized-bed combustor will be developed that will include coal combustion phenomena and will incorporate basic mass transport relationships, bubble mechanics, heat transfer, and configuration effects. A cold model test bed will be designed, constructed, and operated to generate data in support of the effort in developing the mathematical model. In particular, experiments will provide data concerning heat transfer effects of tubes and tube bundles in fluidized beds, bubble formation, dispersion, etc. The conversion-time relationship for a noncatalytic nonisothermal solid-gas reaction was formulated employing a shrinking core model for a single spherical pellet in which for simplicity the solid-gas reaction is approximated by a first order irreversible reaction. The formulation takes into account the changing size of the particle during reaction and also includes the influence of intermolecular gas film diffusion, intraparticle ash layer diffusion, and chemical reaction rate. Numerical calculations are in progress. This formulation is directly applicable in modeling the fluidized-bed reactors. A fluidized-bed reactor, which consists of a fluidization column, air supply system, water supply system, an off-gas system, and instrumentation for temperature and pressure measurement, has been partially designed. The departmental workshop will soon initiate thefluidization column. The equipment needed for the fluidized-bed reactor system is either under order or is to be ordered shortly. (auth)

3044 **Proposed mechanism for ash fouling burning Northern Great Plains lignite.** Tufte, P.H.; Beckering, W. (Bureau of Mines, Grand Forks, ND). *J. Eng. Power;* **97**: 407-412(Jul 1975).

Fouling of boiler heat transfer surfaces by lignite ash continues to be a problem that reduces boiler efficiency and availability. The present study evaluates the fouling mechanism in a microscopic sense. It endeavors to establish a relationship between the identity and mode of occurrence of mineral matter in lignite and the resultant ash deposits. Severe fouling conditions are believed caused by the formation of a melted phase binding material within the deposit. Sodium, volatilized from coal and reacted in the flue gas to form sulfate or carbonate, reacts with a fly ash subspecies (termed matrix parent) to form the integrative matrix within ash deposits. The reactive subspecies (matrix parent) is derived from the inherent ash present in each burning coal particle. However, only inherent ash having elemental compositions lying within a given range is fluxable by sodium to form a sticky, deposit-integrating material. The major elements comprising the matrix are Na, Ca, Al, and Si. A chemical solution to the lignite fouling problem must alter the fluxing sodium or the fluxable matrix parent. (auth)

PETROLEUM

DRILLING AND PRODUCTION

3045 (AERE-R—8055) **Continuous monitoring of fixed offshore platforms for structural failure. A review and assessment of techniques.** Silk, M.G.; Williams, N.R.; Jones, C.H.; Watkins, B.; Cassie, G.E. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Sep 1975. 45p. Dep. NTIS (US Sales Only) $6.00. UK pounds1.00.

The problems of continuously monitoring the structural integrity of fixed off-shore platforms are considered. Various methods of accomplishing the objective are examined and evaluated. (TFD)

3046 (BERC—75/3) **Contracts and grants for cooperative research on enhancement of recovery of oil and gas. Progress review No. 3.** Linville, B. (ed.). (Energy Research and Development Administration, Bartlesville, Okla. (USA). Bartlesville Energy Research Center). Sep 1975. 74p. TIC.

Information on ten grants and thirteen contractual research projects in the ERDA program for enhanced recovery of oil and gas is given. The objectives, technical progress, and background information of each project are summarized. A glossary is included. (JGB)

PROCESSING

3047 Catalytic hydrocarbon conversion process. Beaty, W.R. Jr. (to Continental Oil Co.). US Patent 3,900,430. 19 Aug 1975. Filed date 14 May 1973. 10p.

A process and catalyst is described for converting hydrocarbon oils to desirable components by contacting said oils in the presence of hydrogen under hydrocarbon conversion conditions with a catalyst comprising a catalytic amount of a catalytic metal support on gamma alumina. (Official Gazette)

OIL SHALES AND TAR SANDS

DRILLING, FRACTURING, AND MINING

3048 Method for mining oil shales, tar sands, and other minerals. Johns, R.W. US Patent 3,888,543. 10 Jun 1975. Filed date 3 Sep 1974. 12p.

In the mining of subsurface friable mineral ore deposits, the invention provides a mine configuration and mining system in which the mine has preferably three levels. The first operating level, is positioned substantially at the base of the deposit and has an interconnecting system of tunnels within which the mining apparatus operates. This level further includes conveyors adapted to receive loose ore and transport same to vertical shafts or ore passes which interconnect adjacent operating levels. The second operating level is primarily a collecting level, and is positioned below the first, or mining level, to be parallel therewith. This second level has a tunnel system operatively associated with the vertical ore passes of the first level, and has conveyors which collect the loose ore and carry it to shafts for transport to a final, lower level, from which the ore is removed from the mine. According to the invention, active mining is carried out by the known "Fixed Arch Shield" technique on only one level, the only other levels being ore collecting and haulage levels. There are no levels, or mine workings, above the first mining level, only access and ventilation shafts. By utilizing this mining method and the preferred mine configuration, a complete ore deposit can be removed with minimal surface disturbance, and subsidence can be compensated for by distributing waste in a manner that is esthetically acceptable. (auth)

OIL PRODUCTION, RECOVERY, AND REFINING

IN SITU METHODS, TRUE AND MODIFIED

3049 Recovery of viscous petroleum from asphaltic petroleum containing formations such as tar sand deposits. Allen, J.C.; Woodward, C.D. (to Texaco Inc.). US Patent 3,874,452. 1 Apr 1975. Filed date 11 Mar 1974. 8p.

Viscous, asphaltic petroleum may be effectively recovered from subterranean viscous, asphaltic petroleum containing formations such as tar sand deposits by first injecting into the tar sand formation a quantity of N-methyl-2-pyrrolidone or furfural or a mixture that precipitates asphaltic material from the bituminous petroleum portion of the formation petroleum. Next, solvent injection is terminated and air is injected into the formation, and the formation is ignited by heating or other means to initiate in-situ combustion within the petroleum formation utilizing the precipitated asphaltic materials for fuel for the in situ combustion reaction. Reaction temperatures higher than normal in-situ combustion temperatures are produced, facilitating thermal cracking and in-situ hydrogenation to upgrade the produced crude within the tar sand reservoir. (auth)

3050 Solvent/non-solvent pyrolysis of subterranean oil shale. Tham, M.J.; Closmann, P.J. (to Shell Oil Co.). US Patent 3,880,238. 29 Apr 1975. Filed date 18 Jul 1974. 6p.

In a process for recovering shale oil by injecting and producing fluid into and out of a rubble-containing cavity in an otherwise substantially impermeable subterranean oil shale, the tendency for the flow path to become plugged is reduced by injecting both a hot solvent fluid and a nonsolvent gas at rates correlated so that the cavern remains substantially free of liquid. (auth)

3051 Method of extracting immobile hydrocarbons. Terry, R.C.; Stoddard, X.T. US Patent 3,881,551. 6 May 1975. Filed date 12 Oct 1973. 8p.

A method of extracting immobile hydrocarbons includes the steps of sinking spaced wells into the hydrocarbon formation, fracturing the formation near the bottom of the wells to establish subsurface communication between the wells, passing a heated fluid through the wells and the hydrocarbon formation to obtain a predetermined temperature in the formation and finally passing a solvent material, having the ability to dissolve the immobile hydrocarbon, through the hydrocarbon formation so that the admixture of the solvent and hydrocarbon can be brought to the surface and allowed to solidify into a fuel composition which can be transported at normal atmospheric conditions in solid form and can be easily melted into liquid fuel. (auth)

3052 In situ recovery of hydrocarbons from tar sands. Barry, C.B. (to Ralph M. Parsons Co.). US Patent 3,881,550. 6 May 1975. Filed date 24 May 1973. 10p.

Hydrocarbon products from viscous tar sands are recovered by continuously injecting a hot solvent containing relatively large amounts of aromatics into the formation. Alternatively, steam and solvent are cyclically and continuously injected into the formation to recover the values. The last stimulation is by steam so that solvent is recovered. A third alternative is to continuously inject a mixture of steam and solvent vapors and liquid into the formation. In all cases, the solvent, except perhaps for startup, is produced at the site, as in a conventional topping unit, which alternatively is combined with a conventional visbreaking or reforming unit to increase the volume and/or aromaticity of the solvent produced. (auth)

3053 Heating through fractures to expand a shale oil pyrolyzing cavern. Closmann, P.J. (to Shell Oil Co.). US Patent 3,888,307. 10 Jun 1975. Filed date 29 Aug 1974. 6p.

In a process for recovering shale oil by injecting and producing fluid into and out of a rubble-containing cavity in an otherwise substantially nonporous and impermeable subterranean oil shale formation, hot gas is circulated into and out of the cavity through spaced horizontal fractures to preheat the oil shale formation and increase the rate of oil recovery and cavity expansion. (auth)

SURFACE METHODS

3054 Methods and compositions for refining bituminous froth recovered from tar sands. Moyer, J.L. (to Great Canadian Oil Sands, Ltd.). US Patent 3,884,829. 20 May 1975. Filed date 14 Nov 1972. 6p.

A method is described for refining emulsion-containing bituminous froth having water and mineral matter impurities recovered from tar sands via hot water extraction. A demulsifying quantity of a C_3 to C_7 ketone is added to the froth and then centrifuged. The froth--ketone mixture provides a froth product substantially reduced in water, mineral matter, and emulsions. (auth)

3055 Process for obtaining oil, gas, and byproducts from pyrobituminous shale or other solid materials impregnated with hydrocarbons. Ueta, S.; Ivo, O.C. (to Petroleo Brasileiro S.A. - Petrobras). US Patent 3,887,453. 3 Jun 1975. Priority date 6 Sep 1971, Brazil. 8p.

An improved process is described for obtaining oil, gas, and by-products from pyrobituminous shale or other solid materials impregnated with hydrocarbons. A mist is permitted to form at the output of the reactor, resulting from the extraction of recycling gases passing in countercurrent with the downwardly moving shale. The improvement results in lower costs, higher amounts of extracted material, higher rentability and, accordingly, better economy. (auth)

3056 Process and apparatus for recovering bitumen from bituminous sands. Gray, F.A.; Gray, J.A. US Patent 3,891,550. 24 Jun 1975. Filed date 17 Dec 1973. 8p.

A process and apparatus are described for the separation of the sand component from an admixture of bitumen or oil, sand, and water such as the bituminous sands derived from the Athabasca tar sands located in the Province of Alberta, Canada. A mass of the admixture is compacted and directed against a displaceable oleophilic surface to apply a thin layer to the surface, driving it at a rate sufficient to dislodge the sand from the applied layer, and recovering the bitumen-enriched residue adhered to the surface. (auth)

PROPERTIES AND COMPOSITION

3057 (LERC/RI—75/6) Properties of Utah tar sands: north Seep Ridge area, P.R. Spring deposit. Johnson, L.A.; Marchant, L.C.; Cupps, C.Q. (Energy Research and Development Administration, Laramie, Wyo. (USA). Laramie Energy Research Center). Nov 1975. 19p. Dep. NTIS $4.00.

Results of analyses made of three cores from an area at the northern end of Seep Ridge in the P.R. Spring tar sand deposit in northeastern Utah are reported. Up to five tar sand zones were identified in the north Seep Ridge area. These zones occur between the depths of 9 and 390 feet and have a thickness ranging from 27 to 97 feet. The total tar sand section has good porosity, averaging 20.9 percent of bulk volume; fair permeability, 58.9 md before oil extraction and 384 md after oil extraction; and low oil saturation, 38.6 percent of pore volume. The oil has an average gravity of 10.1° API, an average sulfur content of 0.40 wt percent, and an average nitrogen content of 1.30 wt percent. (auth)

FISSION FUELS

BY-PRODUCTS

DEPLETED URANIUM

3058 (UCRL—51910) **Performance of a uranium getter bed for removing deuterium from a flowing inert gas.** Folkers, C.L.; Maienschein, J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 19 Sep 1975. Contract W-7405-Eng-48. 9p. Dep. NTIS $4.00.

The performance of a uranium trap as a means of removing tritium from an inert gas was measured for varying trap conditions, using deuterium (to represent tritium) in argon at room temperature. Performance was expressed as a purification factor, which is the ratio of deuterium concentration at the inlet to that at the outlet of the trap. Purification factors vary inversely with both the ratio of deuterium to uranium already contained in the trap and with the rate of flow of gas through the trap. Varying the inlet deuterium concentration had no apparent effect. (auth)

FUELS PRODUCTION AND PROPERTIES

3059 **Nuclear chemical engineering.** Axtmann, R.C. (Princeton Univ., NJ). *Nucl. Technol.*; **27**: No. 1, 78-83(Sep 1975).

Chemical engineers comprise a significant segment within the U. S. nuclear industry, yet few study nuclear subjects before they begin their careers. Nuclear chemical engineering is defined, then, as an arena for action rather than a field of knowledge. Of the classical problem areas in nuclear chemical engineering, fuel fabrication and isotope separation have made the best recent progress. Radiation chemical engineering, once an activity of ebullient promise, is nearly moribund. Only rarely do chemical engineers approach the central locus of reactor design; when they do the results are often ambivalent or worse. Surprisingly, perhaps, chemical engineering has made several important contributions to elementary particle physics. Fusion technology presents many challenges for creative chemical engineering, e.g., in fuel recovery, gaseous permeation, and the materials effects that result from ionic bombardment. (auth)

SPENT FUELS REPROCESSING

3060 (CONF-751115—3) **Multipurpose reprocessing hot cell.** Fletcher, R.D. (Aerojet Nuclear Systems Co., Sacramento, Calif. (USA)). 16 Nov 1975. 3p. Dep. NTIS $4.50.

From 23. conference on remote systems technology; San Francisco, California, USA (16 Nov 1975).

A multipurpose hot cell for use in the new head end system is described. The use of a hot cell as part of the routine fuel charging procedure provides considerable flexibility in handling a wide variety of fuel sizes up to 25,000 lb. (LK)

3061 (GA-A—13510) **Thorium utilization program. Quarterly progress report for the period ending May 31, 1975.** (General Atomic Co., San Diego, Calif. (USA)). 15 Aug 1975. Contract AT(04-3)-167. vp. Dep. NTIS $7.60.

The work reported includes the development of unit processes and equipment for reprocessing of High-Temperature Gas-Cooled Reactor (HTGR) fuel and the design and development of an integrated line to demonstrate head-end HTGR reprocessing using unirradiated fuel materials. Work is also described on the evaluation of alternate techniques for fuel reprocessing to surmount possible operating problems with the reference flow sheet and the development of the conceptual design of a target recycle facility to identify the requirements of large-scale recycle of HTGR fuels. (auth)

3062 **Nondestructive assay techniques for recycles ^{233}U fuel for high-temperature gas-cooled reactors.** Rushton, J.E.; Jenkins, J.D.; McNeany, S.R. (Oak Ridge National Lab., TN). *Nucl. Mater. Manage.*; **4**: No. 1, 18-35(Spr 1975).

Nondestructive fissile material assay techniques are reviewed for application to the refabrication of recycled ^{233}U fuel for High Temperature Gas-Cooled Reactors (HTGR). The refabrication processes and fuel characteristics are identified and explained, and nondestructive assay techniques are evaluated in light of these characteristics and assay requirements. It is concluded that currently developed and implemented gamma-ray assay techniques for ^{235}U and ^{239}Pu are not applicable to ^{233}U fuel because of its high radioactivity. Calorimetry has potential for ^{233}U fuel assay if appropriate corrections for isotopic composition can be applied. For most nondestructive assay requirements, active interrogation methods must be employed. Neutron interrogation systems using either ^{252}Cf or ^{124}Sb-Be neutron sources and delayed or prompt fission neutron detection offer the greatest potential for assay of HTGR recycle ^{233}U fuel. The presence of hydrogen in some of the fuel forms during processing and the particulate nature of the HTGR fuel complicate the direct application of these neutron interrogation techniques. Photofission techniques, which offer enhanced penetrability for the assay of bulk fuel quantities or fuel elements, cannot be evaluated for this application because of a lack of basic data. (auth)

WASTE MANAGEMENT

WASTE PROCESSING

3063 (ARH-SA—240) **Processing of radioactive waste solutions in a vacuum evaporator-crystallizer.** Petrie, J.C.; Donovan, R.I.; Van der Cook, R.E.; Christensen, W.R. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 26 Sep 1975. Contract E(45-1)-2130. 27p. (CONF-751107—12). Dep. NTIS $5.00.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Results of the first 18 months' operation of Hanford's vacuum evaporator-crystallizer are reported. This process reduces the volume of radioactive waste solutions and simultaneously converts the waste to a less mobile salt cake. The evaporator-crystallizer is operating at better than design production rates and has reduced the volume of radioactive wastes by more than 15 million gallons. A process description, plant performance data, mechanical difficulties, and future operating plans are discussed. Also discussed is a computer model of the evaporator-crystallizer process. (auth)

3064 (BNWL—1932) **Research and development activities waste fixation program. Quarterly progress report April—June 1975.** McElroy, J.L. (comp.). (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 96p. Dep. NTIS $5.45.

Four engineering-scale in-canister melting tests established melting rates in 8- and 12-in.-diam canisters and investigated feed-rate limitations resulting from the use of in-canister fins. The ceramic melter was fed glass frit, calcine and frit powder, concentrated slurry, and liquid waste with powdered frits. Comparative leach tests demonstrated that the reference waste glass has higher leach resistance than many common minerals. A test program was completed which shows the pressurization potential of calcines stored in sealed canisters and subjected to high temperatures. Tests were made of glass samples to measure the curium leach rate and assess the effect on leachability of alpha radiation damage. Long-term compatibility of certain refractory oxides in molten glass was studied to select improved refractories for joule-heated melters. Glass samples doped with curium were examined to assess radiation damage and to determine helium diffusion coefficients. Vaporization behavior of glass and calcine samples at elevated temperature was investigated to evaluate storage and shipping accident conditions. Several methods of coating calcine particles were tested for alternative waste fixation. Retention of cesium and ruthenium in supercalcines was studied. The computer code system for providing ordered lists of the highest risk sequences from among the myriad failure sequences associated with large fault trees was successfully demonstrated. (LK)

3065 (BNWL-SA—4854) **Chemical durability of glasses containing radioactive fission product waste.** Mendel, J.E.; Ross, W.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1974. 18p. (CONF-740438—2). Dep. NTIS $4.50.

From Annual meeting of the American Ceramic Society; Chicago, Illinois, USA (28 Apr 1974).

Measurements made to determine the chemical durability of glasses for disposal of radioactive waste are discussed. The term

glass covers materials varying from true glass with only minute quantities of crystallites, such as insoluble RuO_2, to quasi glass-ceramics which are mostly crystalline. Chemical durability requirements and Soxhlet extractor leach tests are discussed. (LK)

3066 (BNWL-SA—5454) **Performance of a wiped film evaporator with simulated high level waste slurries.** Dierks, R.D.; Bonner, W.F. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 20p. (CONF-751107—10). Dep. NTIS $4.00.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

The horizontal, reverse taper, wiped film evaporator that was evaluated demonstrated a number of positive characteristics with respect to its applicability in the solidification of nuclear fuel recovery process wastes. Foremost among these is its ability to remove the bulk (80 to 90 percent) of the liquid associated with any of the purex-type high level, intermediate level, or mixed waste slurries. The major disadvantage of the evaporator is its current inability to discharge a product that is low enough in liquid content to avoid sticking to the evaporator discharge nozzle. Also, while the indirect indications of the torque required to turn the rotor and the power drawn by the drive motor are indicative of the liquid content of the discharged product, no reliable correlation has been found to cover all of the possible flow rates and feed stock compositions that the evaporator may be required to handle. In addition, no reliable means has been found to indicate the presence or absence of product flow through the discharge nozzle. The lack of a positive means of moving the product concentrate out of the evaporator and into a high temperature receiver is an undesirable feature of the evaporator. Pulverized glass former, or frit, was added to the evaporator feedstock in a ratio of frit to metal oxides of 2 to 1, and the resulting mixture successfully evaporated to a concentrate containing about 50 percent solids. In general, the performance of the wiped film evaporator evaluated was favorable for its use in a nuclear waste fixation process, however further development of the rotor design, power input, and operating techniques will be required to produce a free flowing solid product. (auth)

3067 (CONF-741026—) **Proceedings of the seminar on the management of plutonium-contaminated solid wastes, Marcoule, France, October 14—16, 1974.** (Nuclear Energy Agency, 75 - Paris (France)). 1974. 250p. (In French and English). Nuclear Energy Agency, Paris.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

Seventeen items have been indexed separately; seven items have been announced in both Nuclear Science Abstracts and ERDA Research Abstracts and ten additional items have been announced in Nuclear Science Abstracts. (LK)

3068 (CONF-741026—, pp 62-79) **Overview of management programs for plutonium-contaminated solid waste in the USA.** Ramsey, R.W. Jr. (Atomic Energy Commission, Washington, DC); Daly, G.H.; Blasewitz, A.G.; Cooley, C.R.; Richardson, G.L. 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

Programs for transuranium—contaminated solid wastes (TRU) in the U.S.A. are emphasizing a reduction in waste generation and the development of appropriate treatments to reduce the volume of wastes requiring interim storage and final disposal. Research and Development is emphasizing the establishment of sufficient information on treatment, hazards and storage to adopt a standardized procedure for handling wastes during an interim retrievable period and for final disposal. Federal responsibility for TRU waste is being proposed except for minimum amounts acceptable for commercial burial. (auth)

3069 (CONF-741026—, pp 107-110) **Management of plutonium contaminated wastes at Rocky Flats.** Owen, J.B. (Dow Chemical U.S.A., Golden, CO). 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

The U. S. Atomic Energy Commission's (USAEC) Rocky Flats Plant handles hundreds of kilograms of plutonium each year. Significant quantities of waste materials and equipment contaminated with plutonium are generated. Management systems and techniques have been developed and are in use which reduce both the volume of waste generated and the quantity of plutonium involved. Containers have been developed and are in use which meet the 20-year retrievability requirement of USAEC Immediate Action Directive (IAD) 0511-21. (auth)

3070 (CONF-741026—, pp 124-132) **Long range management of transuranium-contaminated solid wastes at Savannah River.** Albenesius, E.L.; Reinig, W.C. (E.I. du Pont de Nemours and Co., Aiken, SC). 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

The Savannah River Plant, an 80,000-hectare USAEC production site in the southeastern United States, has generated solid wastes contaminated with 60,000 Ci of transuranium nuclides, chiefly ^{239}Pu, ^{238}Pu, and ^{244}Cm. These wastes, along with 300,000 Ci of transuranium wastes from other AEC sites, are stored in an 80-hectare area on the plantsite. A comprehensive planning program to retrieve and convert the wastes to noncombustible and nondispersive forms in preparation for centuries-long storage in an engineered repository is discussed. (auth)

3071 (CONF-741026—, pp 172-185) **Acid digestion process for treatment of combustible wastes.** Cooley, C.R.; Lerch, R.E. (Westinghouse Hanford Co., Richland, WA). 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

Acid digestion is a process being developed at the Hanford Engineering Development Laboratory (HEDL) in Richland, Washington, to reduce the volume of alpha-contaminated combustible waste by converting it into a non-combustible residue. Typical waste materials such as polyvinylchloride (PVC), polyethylene, paper and other cellulose materials, ion exchange resin, all types of rubber, etc., are digested in hot (230 to 270°C) concentrated sulfuric acid containing nitric acid oxidant to form inert residues having less than 4 percent of their original volume. The process is currently being tested in a non-radioactive Acid Digestion Test Unit (ADTU) using all glass equipment. Engineering tests to date have shown acid digestion to be a potentially attractive method for treating combustible waste materials. (auth)

3072 (CONF-741026—, pp 193-206) **Plutonium contaminated solid waste programs.** Johnson, L.J.; Jordan, H.S. (Los Alamos Scientific Lab., NM). 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

Development of handling and storage criteria for plutonium contaminated solid waste materials is discussed. Data from corrosion and radiolytic attack studies are reviewed. Instrumentation systems developed for solid waste management applications at the 10 nCi Pu/g waste material level is described, and their sensitivity and operational limitations reviewed. Current programs for the environmental risk analysis of past waste disposal areas and for development of technology for the volume reduction and chemical stabilization of transuranic contaminated solid waste are outlined. (auth)

3073 (CONF-741026—, pp 207-222) **Conceptual system for handling alpha-bearing wastes.** Jansen, G.; Schneider, K.J.; Hammond, V.L. (Battelle Pacific Northwest Labs., Richland, WA). 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

This paper presents the design of a hypothetical system for identifying, transporting, processing, and storing non-high-level radioactive wastes exclusive of mine tailings. Waste identification is based on state and federal regulations and toxicity indexes as a function of decay time. Because of a multiplicity of small sources of liquid and solid wastes, the waste repository is equipped with a processing facility for receiving, sorting, solid volume reduction, liquid volume reduction and solidification, and packaging wastes at a rate equal to the generation rate in 1980. Storage of canned waste is partly in shielded and partly in unshielded high-integrity warehouses for an interim period of 100 years. Costs for this hypothetical system in 1973 dollars are estimated to be $30 million for transportation, $20 million for the processing facility, $24 million for the storage facility, and $7 million in annual operating costs. (auth)

3074 (CONF-750542—6) **Post treatment of high-level nuclear fuel wastes.** Berreth, J.R.; Cole, H.S.; Hoskins, A.P.; Lewis, L.C.; Samsel, E.G. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. Contract AT(18-1)-1375. 25p. Dep. NTIS $4.50.

From 77. annual meeting of the American Ceramic Society; Washington, District of Columbia, USA (3 May 1975).

The glass-ceramic product prepared from fluidized-bed calcined synthetic commercial wastes, based on data obtained to date, has many of the properties desired for long-term storage. Although more characterization is necessitated, the product's high-calcine content will decrease the number of storage canisters required and use a minimum of product-forming additives, resulting in significant process cost savings. The product remains in a solid, nonflowing form at temperatures close to the preparation temperature and yet is prepared at relatively low temperatures. The product has void spaces to accommodate radiolytic gas formation, but is hard and dense and has very low leach rates. Process features, such as no direct product contact with furnace or storage canisters, will minimize corrosion of both process equipment and storage canisters. (auth)

3075 (CONF-751104—4) **Some activities in the United States concerning the physics aspects of actinide waste recycling.** Raman, S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 15p. Dep. NTIS $4.00.

From IAEA advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

Reactor types being considered in the United States for the purpose of actinide waste recycling are discussed briefly. The reactor types include thermal reactors operating on the 3.3 percent $^{235}U—^{238}U$ and the $^{233}U—^{232}Th$ fuel cycles, liquid metal fast breeder reactors, reactors fueled entirely by actinide wastes, gaseous fuel reactors, and fusion reactors. Cross section measurements in progress or planned toward providing basic data for testing the recycle concept are also discussed. (auth)

3076 (CONF-751107—4) **Fluidized-bed calcination of simulated commercial high-level radioactive wastes.** Freeby, W.A. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Nov 1975. Contract AT(10-1)-1375. 17p. Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

Work is in progress at the Idaho Chemical Processing Plant to verify process flowsheets for converting simulated commercial high-level liquid wastes to granular solids using the fluidized-bed calcination process. Primary emphasis in the series of runs reported was to define flowsheets for calcining simulated Allied-General Nuclear Services (AGNS) waste and to evaluate product properties significant to calcination, solids storage, or post treatment. Pilot-plant studies using simulated high-level acid wastes representative of those to be produced by Nuclear Fuel Services, Inc. (NFS) are also included. Combined AGNS high-level and intermediate-level waste (0.26 M Na in blend) was successfully calcined when powdered iron was added (to result in a Na/Fe mole ratio of 1.0) to the feed to prevent particle agglomeration due to sodium nitrate. Long-term runs (approximately 100 hours) showed that calcination of the combined waste is practical. Concentrated AGNS waste containing sodium at concentrations less than 0.2 M were calcined successfully; concentrated waste containing 1.13 M Na calcined successfully when powdered iron was added to the feed to suppress sodium nitrate formation. Calcination of dilute AGNS waste by conventional fluid-bed techniques was unsuccessful due to the inability to control bed particle size—both particle size and bed level decreased. Fluid-bed solidification of AGNS dilute waste at conditions in which most of the calcined solids left the calciner vessel with the off-gas was successful. In such a concept, the steady-state composition of the bed material would be approximately 22 wt percent calcined solids deposited on inert particles. Calcination of simulated NFS acid waste indicated that solidification by the fluid-bed process is feasible. (auth)

3077 (HEDL-TME—75-41) **Commercial Alpha Waste Program. Quarterly progress report, October—December 1974.** Cooley, C.R. (comp.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Feb 1975. Contract AT(45-1)-2170. 47p. Dep. NTIS $4.00.

This is the third Quarterly Progress Report on the Commercial Alpha Waste Program being conducted at the Hanford Engineering Development Laboratory (HEDL) for the Division of Waste Management and Transportation, USERDA. Data on waste generation during commercial fabrication of FFTF fuel are discussed. Expected volumes and activity levels of waste generated during commercial fuel reprocessing operations are also discussed. Progress to date on development of the acid digestion process for treating combustible wastes is discussed as well as work on product storage and disposal of wastes. Data on compaction and incineration of HEPA filters are presented. (auth)

3078 (ICP—1080) **Actinide removal from ICPP wastes.** McIsaac, L.D.; Baker, J.D.; Tkachyk, J.W. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). Aug 1975. Contract E(10-1)-1375. 54p. Dep. NTIS $5.45.

The actinide removal program at the ICPP is discussed and potential separation procedures reviewed. Extensive extraction and stripping data are reported for the most promising extractants: dibutylbutyl phosphonate (DBBP), dihexyl-N, N-diethylcarbamylmethylemephosphonate (DHDECMP) and the butyl homologue, DBDECMP. Both synthetic and actual ICPP nuclear fuel reprocessing waste have been used. Solubility measurements for DHDECMP and DBDECMP are also reported. Analytical procedures developed for actinide analysis in ICPP waste are outlined. A conceptual process flowsheet for actinide removal at the ICPP is presented. (auth)

3079 (LA—6100-PR) **Transuranic Solid Waste Management Programs. Progress report, July—December 1974.** (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-36. 60p. Dep. NTIS $5.45.

Progress is reported for three transuranic solid waste management programs funded at the Los Alamos Scientific Laboratory by the Energy Research and Development Administration Division of Waste Management and Transportation. Under the Transuranic Waste Research and Development Program, a completed evaluation of stainless steel drums showed that although the material has superior corrosion-resistant properties, its higher cost makes a thorough investigation of other container systems mandatory. A program to investigate more economical, nonmetallic containers is proposed. Preliminary fire tests in mild steel drums have been completed with fire propagation not appearing to be a problem unless container integrity is lost. Investigation of the corrosion of mild steel drums and the evaluation of potential corrosion inhibitors, in a variety of humid environments, continues. Experimental results of both laboratory and field investigations on radiolysis of transuranic elements in hydrogenous waste are discussed. Progress in the development of instrumentation for monitoring and segregating low-level wastes is described. New plans and developments for the Transuranic-Contaminated Solid Waste Treatment Development Facility are presented. The current focus is on a comparison of all alternative waste reduction systems toward a relative Figure of Merit with universal application. Drawings, flowsheets, and building layouts are included, and the proposed incinerator device is detailed. The release mechanisms, inter- and intraregional transport mechanisms, and exhumation studies relevant to the Evaluation of Transuranic-Contaminated Radioactive Waste Disposal Areas Program are defined and analyzed. A detailed description is given of the formulation of the computer simulation scheme for the intraregional biological transport model. (auth)

WASTE DISPOSAL AND STORAGE

3080 (ARH—2806-3Q) **Radioactive liquid wastes discharged to ground in the 200 Areas during the first three quarters of 1973.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 15 Jan 1974. Contract AT(45-1)-2130. 89p. Dep. NTIS $7.50.

Radioactive liquid wastes discharged to ground during the first three quarters of 1973 and since startup within the Manufacturing and Waste Management Division control zone are summarized in tabular form. The wastes discharged during 1973 to each active disposal site are detailed on a month-to-month basis. (LK)

3081 (ARH—3093-1Q) **Radioactive liquid wastes discharged to ground in the 200 Areas during first quarter 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 22 Jul 1974. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

Tables summarizing the radioactive liquid wastes discharged to ground during the first quarter of 1974 and since startup within the Operations Division Control zone are presented. Estimates of radioactivity discharged to individual ponds, cribs, and specific retention sites are also tabulated. (LK)

3082 (ARH—3093-2Q) **Radioactive liquid wastes discharged to ground in the 200 Areas during first half 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 31 Oct 1974. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

A summary of the radioactive liquid wastes that have been discharged to ground in the 200 areas during the first half of 1974 is presented in tabular form. Cumulative data since plant startup are also given. (LK)

3083 (ARH—3093-3Q) **Radioactive liquid wastes discharged to ground in the 200 Areas during the first three quarters of 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 31 Dec 1974. Contract AT(45-1)-2130. 83p. Dep. NTIS $7.25.

An overall summary of radioactive liquid wastes discharged to ground during the first three quarters of 1974 and since startup

within the Production and Waste Management control zone is presented in tabular form. Estimates of the radioactivity discharged to individual ponds, cribs, and specific retention sites are given. (LK)

3084 (ARH—3093-4Q) **Radioactive liquid wastes discharged to ground in the 200 Areas during 1974.** Anderson, J.D. (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 28 Mar 1975. Contract AT(45-1)-2130. 84p. Dep. NTIS $7.25.

Radioactive liquid wastes discharged to ground during 1974 and since startup within the Production and Waste Management control zone are summarized in tabular form. Estimates of the radioactivity discharged to individual ponds, cribs, and retention sites are also summarized. (LK)

3085 (BNL—20421) **Tritium storage development. Progress report No. 4, April—June 1975.** Columbo, P. (Brookhaven National Lab., Upton, N.Y. (USA)). Jul 1975. 33p. Dep. NTIS $4.75.

Preliminary PITC and PC formulations were evaluated with respect to their specific tritiated waste loadings and materials cost. Experimental data suggest the use of lumnite PITC composites, although portland cement formulations are desirable if their density can be increased. Increasing the water/cement ratio was found to increase the leach rate of lumnite PITC. Container pressurization due to evaporative water loss in concrete as a result of temperature response of a concrete monolith in a convective environment was found to be substantial. The conceptual process for the fixation of tritiated aqueous waste in PITC is discussed. Leach test results for zirconium hydride in various aqueous environments are presented. These results suggest that a stable hydride, such as is formed by zirconium, may be attractive as a tritium storage medium. (auth)

3086 (BNWL-SA—5507) **Alternatives for radioactive waste management.** Bartlett, J.W. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Oct 1975. Contract AT(45-1)-1830. 21p. (CONF-751044—1). Dep. NTIS $4.25.

From ANS topical meeting on nuclear safety; Tucson, Arizona, USA (5 Oct 1975).

The safety aspects of waste management alternatives are emphasized. The options for waste management, their safety characteristics, and the methods that might be used to evaluate the options and their safety are outlined. (LK)

3087 (CONF-741026—, pp 111-123) **Storage of transuranic contaminated solid wastes at the Idaho National Engineering Laboratory.** Wehmann, G. (Atomic Energy Commission, Idaho Falls, ID); Hickman, W.W. 1974.

From Seminar on the management of plutonium-contaminated solid wastes; Marcoule, France (14 Oct 1974).

In Proceedings of the seminar on the management of plutonium-contaminated solid wastes.

The storage method for low-level transuranic wastes employed at the Idaho National Engineering Laboratory is discussed in detail. The techniques used for wastes containing greater than (10) nanocuries of transuranic material per gram of waste as well as the technique for lesser concentrations of transuranic wastes are described. The safety, efficiency and adequacy of these storage methods are presented. (auth)

3088 (HW—64375) **Radioactive contamination in liuid wastes discharged to ground at the separations facilities through December 1959.** McConiga, M.W. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 13 May 1960. 28p. Dep. NTIS $5.00.

Declassified 17 Dec 1973.

Open disposal sites at the separation areas have received approximately 1.48×10^{11} liters since startup. Approximately 2,509 Ci of fission products and 446 g of plutonium were contained in this waste. Exclusive of large volume open waste disposal sites, the estimated volume of waste discharged to ground since startup was 1.54×10^{10} liters. Included in this is over 2,515,200 Ci of fission products and 43.10 k of plutonium. (auth)

ENVIRONMENTAL ASPECTS

3089 (GAT-T—2374) **Chromium recovery from sludges produced from chromate-inhibited cooling water.** Deacon, L.E.; Holland, M.E.; Kaplan, R.I. (Goodyear Atomic Corp., Piketon, Ohio (USA)). 12 Sep 1975. Contract E(33-2)-1. 16p. (CONF-750967—5). Dep. NTIS $4.00.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Laboratory investigations of methods to reclaim chromium from sludge are summarized. Among the methods tried were wet oxidation techniques using peroxide, persulfate, and permanganate salts as oxidants and gaseous oxidation techniques using ozone, chlorine, and fluorine. However, the most successful and technically feasible approach discovered was calcination of the sludge with added soda ash at 850 to 900°C for about 30 minutes in an open-air calciner. Recovery yields of up to 75 percent were recorded. Calcination converts the chromium to sodium chromate, which is water-leachable and, hence, can be returned to the cooling water system. Residue after leaching may contain sufficient lime to warrant its reuse as a precipitation agent in the process. (auth)

REGULATIONS

ACCOUNTABILITY AND SAFEGUARDS

3090 (HEDL-SA—950) **FFTF fuel pin nondestructive assay measurements.** Goris, P.; DeMerschman, A.W. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Oct 1975. Contract E(45-1)-2170. 17p. (CONF-751017—10; SM—201/84). Dep. NTIS $4.00.

From Symposium on safeguards of nuclear materials; Vienna, Austria (20 Oct 1975).

The Hanford Engineering Development Laboratory (HEDL) is evaluating utilization of a Cf-252 fuel pin scanner as a nondestructive assay technique to determine shipper-receiver assays of fissile materials in Liquid Metal Fast Breeder Reactor type fuel pins. All Fast Flux Test Facility fuel pins produced for cores 1 and 2 are being assayed with the fuel scanner. Results have been compared with chemical measurements. In a set of 49 pins, using 6 scans per pin, no significant differences were observed between nondestructive assay and chemical assay on 6 randomly selected pellets from each fuel pin after it had been destructed. Shipper-receiver differences for outer core fuel pins under HEDL calibration of the fuel pin scanner agree with chemical shipper-receiver differences within experimental limitations. Quality control data over a 2-year period involving 1286 observations for 7 fuel pin standards indicate a long-term random error of 0.84 percent relative standard deviation per single fuel pin assay. A random variation of S = 0.84 percentper single fuel pin assay has little or no effect on the uncertainty in total Pu/sub f/ in statistically large numbers of fuel pins. Long-term agreement with given quality control fuel pins ranges from -0.23 percent to +0.12 percent. The overall weighted averaged agreement is -0.10 percent which indicates an apparent bias trend for the fuel pin scanner under the present two-point calibration technique. In a large number of fuel pins composing a shipment, the uncertainty for total fissile plutonium, as determined by the fuel pin scanner, is due to the uncertainty of assay of the fuel pin standards. (auth)

ISOTOPE AND RADIATION SOURCE TECHNOLOGY

RADIATION SOURCES

3091 (DP-MS—75-80) **Survey of potential markets for devices using Californium-252.** Permar, P.H. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 14p. (CONF-751114—1). Dep. NTIS $4.00.

From Californium-252 utilization meeting; San Diego, California, USA (4 Nov 1975).

Potential applications for devices or systems containing ^{252}Cf in the years from 1975 to 1980 are estimated. The estimated number of devices and associated business value were derived from a survey of 46 industrial, educational and governmental organizations conducted from Jan. to May, 1975. Applications for devices and systems based on ^{252}Cf are expected to increase by a factor of 7 in the 6-y period from 1975 to 1980. The annual business value of ^{252}Cf devices should increase from $1.5 million in 1975 to $10.8 million in 1980. The potential European market should be several times as large as the US market, based on actual sales of ^{252}Cf, which have been two to four times greater in Europe than in the US. (auth)

ISOTOPIC POWER SUPPLIES

3092 (BNWL—1845-13) **Pacific Northwest Laboratory monthly report to Advanced Nuclear Energy Systems, Space and Special Purposes Division for July 1975.** Fullam, H.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-1830. 8p. Dep. NTIS $4.00.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general areas: long-term SrF_2 compatibility data; chemical and physical property data on $^{90}SrF_2$; and capsule property data such as external corrosion resistance, crush strength, etc. The current program is designed to provide the required information. (auth)

3093 (MLM—2213) **Design, testing, and fabrication of heat sources for underwater application.** Luthy, D.F.; Anderson, C.G. (Mound Lab., Miamisburg, Ohio (USA)). 5 Nov 1975. Contract E-33-1-GEN-53. 13p. Dep. NTIS $4.00.

The sequence of events in the design, testing and fabrication of a radioisotopic heat source using available $^{238}PuO_2$ fuel that would be amenable to a Navy 0.5-W (electrical) Radioisotopic Thermoelectric Generator for undersea application is discussed. Various designs were considered as a function of heat leak in order to adopt the most desirable capsule for a volume-constrained application. Testing considerations are discussed for capsule compliance with IAEA/ENEA Safety Series 6 and 33 and 10 CFR 71. (auth)

3094 (TID—26868) **Program of thermoelectric generator testing and RTG degradation mechanisms evaluation. Progress report No. 11.** (Jet Propulsion Lab., Pasadena, Calif. (USA)). May 1975. Contract AT(04-3)-959. 86p. Dep. NTIS $7.50.

Research progress for March-April 1975 is reported on the development of a radioisotope-fueled thermoelectric generator. The report is divided into two parts. Part I-Silicon Germanium Technology contains sections on experiments with silicon nitride-coated hot shoes, resistance and thermal conductivity of multifoil insulation, material compatibility experiments, TBC-1 generator performance analysis, and thermoelectric property characteristics. Part II-Thermoelectric Generator Test and Evaluation contains sections of high performance generator HPG SN-2, transit generator QM-III, ring converter, MHW-TBC-1,and RCA reference generator. (TD)

DESIGN AND FABRICATION

3095 (BNWL—1845-12) **Pacific Northwest Laboratory quarterly report to Advanced Nuclear Energy Systems, Space and Special Purposes Division, April—June 1975.** Fullam, H.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Jul 1975. Contract E(45-1)-1830. 21p. Dep. NTIS $4.00.

At Hanford, strontium will be separated from the high-level waste, converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). The encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general areas: long-term SrF_2 compatibility data; chemical and physical property data on $^{90}SrF_2$; and capsule property data such as external corrosion resistance, crush strength, etc. The current program is designed to provide the required information. (auth)

3096 (BNWL—1845-15) **Pacific Northwest Laboratory monthly report to Advanced Nuclear Energy Systems, Space and Special Purposes Division for August 1975.** Fullam, H.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-1830. 7p. Dep. NTIS $4.00.

At Hanford, strontium will be separated from the high-level waste, then converted to the fluoride, and doubly encapsulated in small, high-integrity containers for subsequent long-term storage. The fluoride conversion, encapsulation and storage will take place in the Waste Encapsulation and Storage Facilities (WESF). This encapsulated strontium fluoride represents an economical source of ^{90}Sr if the WESF capsule can be licensed for heat source applications under anticipated use conditions. The objectives of this program are to obtain the data needed to license $^{90}SrF_2$ heat sources and specifically the WESF $^{90}SrF_2$ capsules. The information needed for licensing can be divided into three general areas: long-term SrF_2 compatibility data; chemical and physical property data on $^{90}SrF_2$; and capsule property data such as external corrosion resistance, crush strength, etc. The current program is designed to provide the required information. (auth)

3097 (DP-MS—75-63) **Fabrication of granule and pellet heat sources from oxalate-based $^{238}PuO_2$.** Bickford, D.F.; Rankin, D.T. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 38p. (CONF-751038—2). Dep. NTIS $5.00.

From American Ceramic Society; Seattle, Washington, USA (29 Oct 1975).

Suitable fuel forms for radioisotopic thermoelectric generators are granules of high internal density (greater than 95 percent of theoretical) or geometric shapes (80 to 90 percent dense) such as pellets or spheres. Both forms can be made from calcined $^{238}Pu(III)$ oxalate. The conditions for processing PuO_2 are controlled during fuel form fabrication to ensure pellet integrity; to control density, grain size, and porosity distribution; and to minimize the fraction of potentially respirable fines. The competing phenomena of expansion caused by radiation damage (including helium generation from radioactive decay of plutonium) and shrinkage caused by sintering must be controlled to assure dimensional stability. The variation of microstructure and related physical properties with process parameters is discussed. (auth)

3098 (DPST—75-128-8) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Aug 1975. Contract AT(07-2)-1. 42p. Dep. NTIS $5.00.

Progress during August 1975 in the development of $^{238}PuO_2$ heat sources is reported. In studies to characterize $^{238}PuO_2$, the following were concluded: particle size was determined to be the most important characteristic affecting the variation in fabricability of $^{238}PuO_2$; problem feed consists of smaller particles (2 to 4 μm) than older, acceptable feed (4 to 6 μm). The particle size of new feed has varied from 3 to 10 μm primarily as a result of varying precipitation temperature; equations have been developed from statistically designed precipitation experiments that relate precipitation temperature, nitric acid concentration, and plutonium concentration to particle size; characteristics of acceptable feed have been defined: a particle size mode of 4.5 to 6.0 μm, with an agglomeration index of 20 to 50 wt percent, and 0 to 15 wt percent of fines (less than 2 μm particles); precipitation temperature is the most important variable affecting particle size; and desired particle characteristics can be achieved by precipitating at 35 +- 5°C, 1.2 +- 0.1M nitric acid, and 4 to 7 g/l plutonium in the feed solution. No deleterious effects from ultrasonic decontamination were observed on either fuel form simulants or the iridium containment shells. Helium release studies show that shards can be stored for over a year without producing microstructural damage in hot-pressed products. Temperature gradients of only 50°C during shard seasoning can affect product quality. Presintering of cold-pressed pellets before breakup produces shards for the Milliwatt Radioisotopic Thermoelectric Generator Program (Milliwatt) with a minimum of fines. Fines content of these shards compares favorably with the fines associated with the Mound Laboratory hydroxide shards. (auth)

3099 (DPST—75-128-9) **Savannah River Laboratory monthly report: ^{238}Pu fuel form processes.** (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1975. Contract AT(07-2)-1. 27p. Dep. NTIS $5.00.

Progress during Sept. 1975 in the development of $^{238}PuO_2$ heat sources is reported. Characterization of Los Alamos Scientific Laboratory (LASL) samples confirms that small mode size and high tap density of as-received powder are indicative of poor fabricability. Helium bubble formation at grain boundaries of shards aged 20 months did not affect fracture behavior at room temperature. Ultrasonic decontamination of iridium-clad spheres with detergent and nitric acid gave results comparable to the Mound Laboratory procedure of soaking in concentrated HNO_3-HF solutions. Design of the Plutonium Experimental Facility is 90 percent complete. (auth)

3100 **Artificial heart system thermal converter and blood pump component research and development.** Pouchot, W.D.; Bifano, N.J.; Hanson, J.P. pp 1223-1231 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A bench model version of a nuclear-powered artificial heart system to be used as a replacement for the natural heart was constructed and tested as a part of a broader U. S. ERDA program. The objective of the broader program has been to develop a prototype of a fully implantable nuclear-powered total artificial heart system powered by the thermal energy of plutonium-238 and hav-

ing minimum weight and volume and a minimum life of ten years. As a forward step in this broader program, component research and development has been carried out directed towards a fully implantable and advanced version of the bench model (IVBM). Some of the results of the component research and development effort on a Stirling engine, blood pump drive mechanisms, and coupling mechanisms are presented. The Stirling-mechanical system under development is shown. There are three major subassemblies: the thermal converter, the coupling mechanism, and the blood pump drive mechanism. The thermal converter uses a Stirling cycle to convert the heat of the plutonium-238 fueled heat source to a rotary shaft power output. The coupling mechanism changes the orientation of the output shaft by 90 degrees and transmits the pumping power by wire-wound core flexible shafting to the pumping mechanism. The coupling mechanism also provides routing of the coolant lines which carry the cycle waste heat from the thermal converter to the blood pump. The change in orientation of the thermal converter output shaft is for convenience in implanting in a calf. This orientation of thermal converter to blood pump seemed to give the best overall system fit in a calf based on fit trials with wooden models in a calf cadaver. (RCK)

HYDROGEN

PRODUCTION

ELECTROLYSIS

3101 **Evaluation of electrocatalysts for water electrolysis in alkaline solutions.** Miles, M.H. (Brookhaven National Lab., Upton, NY). *J. Electroanal. Chem. Interfacial Electrochem.*; **60**: 89-96(1975).

Cyclic voltammetry was used to test various metallic elements, compounds, and alloys as electrocatalysts for the hydrogen and oxygen evolution reaction under conditions typically encountered in commercial water electrolysis. The better electrocatalysts are readily identified and comparisons with other types of studies agree favorably. The periodic trends observed for the hydrogen evolution reaction on transition metals correlate well with trends observed in modern values for the electronic work functions. The experimental results suggest that electronic properties are a major factor affecting catalysis and that these properties can be favorably modified by combining the proper elements. (auth)

3102 **Hydrogen: a versatile element.** Bamberger, C.E.; Braunstein, J. *Am. Sci.*; **63**: No. 4, 438-447(1975).

The following methods of hydrogen production are discussed: electrolysis, water-gas catalytic process, steam-hydrocarbon process, and thermochemical cycles. Primary sources of energy that can be used to produce hydrogen are wind, oceanic thermal gradients, solar energy, and nuclear energy. Characteristics of hydrogen are considered. Some industrial uses of hydrogen predicted to have the largest impact on future energy needs are reported. Transportation applications of hydrogen are reviewed. (LK)

BIOSYNTHESIS

3103 (ORNL-TM—4777, pp 105-148) **Bioengineering research and development.** Jul 1975.

In Experimental Engineering Section semiannual progress report.

Three major activities were pursued in the bioprocess development area: the enzyme-catalyzed production of hydrogen, the purification of erythropoietin, and the development of a bioreactor. Although diverse in detail, these activities share a common bond in that each is primarily an engineering development using or being applied to a biological process. In the enzyme-catalyzed reduction of water by sodium pyruvate, parameters which affect the rate of hydrogen production are pH, temperature, and substrate (sodium pyruvate) concentration. The optimum pH hydrogen production is 6.5 to 6.7. The initial rate of hydrogen production follows the Arrhenius relationship in the temperature range 25 to 50°C. A total of 164 liters of sheep plasma was processed to obtain erythropoietin (EPO). The average yield was 40 EPO units per kilogram of sheep body weight. A tapered fluidized-bed bioreactor was used successfully to process a synthetic nitrate waste stream. The reactor contained denitrifying bacteria attached to 65- and 200-mesh coal to convert the nitrate to nitrogen gas. An aerated stirred-tank reactor was used to process a synthetic phenol waste stream. A yeast microorganism, T. cutaneum, was used in the reactor to metabolize the phenol. (LK)

STORAGE

CHEMISORPTION

3104 (EIR—288) **Lectures given at the course on fundamentals of hydrogen energy, Caracas, Venezuela, October 6—10, 1975.** (Eidgenoessisches Inst. fuer Reaktorforschung, Wuerenlingen (Switzerland)). Aug 1975. 35p. Dep. NTIS (US Sales Only) $4.75.

Four different forms of storing hydrogen are discussed: as a gas under pressure, cryogenic storage as a liquid, in the form of metallic hydrides, and storage in various chemical forms. Transmission in cross-country pipelines is covered. Industrial utilization of hydrogen is surveyed. The two papers are abstracted separately. (LK)

3105 (EIR—288, pp vp Paper 1) **Hydrogen storage and transmission methods.** Seifritz, W. (Federal Institute for Reactor Research, Wuerenlingen, Switzerland). Aug 1975.

In Lectures given at the course on fundamentals of hydrogen energy, Caracas, Venezuela, October 6—10, 1975.

Hydrogen can be stored in four forms: as a gas under pressure, cryogenic storage as liquid, in the form of metallic hydrides, and storage in various chemical forms. These different forms are discussed in more detail. Furthermore, the transmission of hydrogen in cross-country pipelines together with an economic analysis and a comparison with natural gas transmission is presented. (auth)

INDUSTRIAL AND COMMERCIAL USE

3106 **TENTH INTERSOCIETY ENERGY CONVERSION ENGINEERING CONFERENCE, NEWARK, DELAWARE, AUGUST 18—22, 1975.** New York; United States of America (USA); Institute of Electrical and Electronics Engineers, Inc. (1975). 1572p. (CONF-750812—). $50.00.

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

The 227 papers presented at the conference cover solar buildings, solar heating and cooling, solar thermal electric generation, solar utilization, space solar systems, LMFBR, energy storage and components, automotive engines, fuel cells, urban systems, nuclear power systems, thermionic energy conversion; photovoltaic conversion lithium batteries, topping cycles, unique engines, molten salt/solid electrolyte batteries, synthetic liquid fuels from coal and oil shale, energy conservation, thermoelectric systems, aqueous batteries, alternative fuels, isotopic power systems, Stirling cycle engines, wind systems, Brayton cycle systems, hydrogen, biomedical power, Rankine cycle systems, wind system applications, and heat pipe applications. The papers were processed individually for NSA and the ERDA energy data base. (LK)

3107 (EIR—288, pp vp Paper 2) **Industrial utilization of hydrogen.** Seifritz, W. (Federal Institute for Reactor Research, Wuerenlingen, Switzerland). Aug 1975.

In Lectures given at the course on fundamentals of hydrogen energy, Caracas, Venezuela, October 6—10, 1975.

A survey on the industrial utilization of hydrogen is given including ammonia production, petroleum refining, methanol production, iron- and steel-making processes, coal gasification, shale and tar sand treatment, hydrogen in the transportation sector and other uses of hydrogen. Furthermore, some possible uses of oxygen are discussed because in a new hydrogen age oxygen will be produced in considerable quantitites as a byproduct of hydrogen. (auth)

OTHER SYNTHETIC AND NATURAL FUELS

HYDROCARBON FUELS

3108 (JUL—1188) **Pyrolysis of methane by microwaves. Part I.** Avni, R.; Winefordner, J.S.; Nickel, H. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Apr 1975. 56p. Dep. NTIS (US Sales Only) $5.50.

The pyrolysis of methane and mixtures of argon-methane by microwaves (2450 MHz) was investigated in the study of the mechanism of pyrocarbon formation. The microwave plasma diagnostic study was performed using electrical probes, namely, the double floating probe technique. Parameters such as electric field

strength and current densities were measured and from their relationship the electron temperature, electric conductivity, and electron and ion densities were evaluated as function of gas pressure, microwave power input, and distance of the probe from the microwave cavity. Various spectroscopic techniques were used for the measurement of temperatures in the microwave plasma; the "reversal temperature" by measuring the intensities of the electronic vibrational bands of CN and OH molecules and "rotational temperature" from the measured intensities of rotational OH lines. The "rotational" as well as the "reversal temperature" were found to be identical and this temperature was assumed to be the temperature of the gas in the microwave plasma. Energy balance calculation, based upon the electrical energy input and thermal losses, were performed in order to determine if steady state conditions existed in the microwave plasma. Emission and absorption spectroscopy were used for determining the active species formed in the pyrolysis of methane and also of mixtures of CH_4-Ar, by the microwave plasma. (auth)

ALCOHOL FUELS

3109 (LBL—3278) **Study of the rotorfermentor and the kinetics of ethanol fermentation.** Margaritis, A.; Wilke, C.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 338p. Dep. NTIS $11.00.

Thesis.

A bench scale pilot plant was designed and built to test the feasibility of the Rotorfermentor as a device for potential use in the fermentation industry. The Rotorfermentor is a fermentation device designed to achieve high cell concentrations. This is achieved by filtration through a rotating microporous membrane enclosed inside the fermentor. The cell-free filtrate along with other metabolic products go through the membrane while the growing cells are left inside the fermentor. The simultaneous cell growth and cell concentration is the essential characteristic of the Rotorfermentor which in principle may replace the functions of an ordinary continuous stirred tank fermentor plus cell centrifuge. Depending on particular process conditions the application of the Rotorfermentor may result in lower capital investment costs. The operational feasibility of the Rotorfermentor has been demonstrated by carrying out transient growth ethanol fermentation experiments. Both the cell concentration and ethanol productivity per unit fermentor volume were found to be much higher than those for an ordinary C.S.T. fermentor. Basic ethanol fermentation kinetic studies on Saccharomyces cerevisiae ATCC No. 4126 were carried out in an ordinary C.S.T. fermentor. It was found that both oxygen and glucose concentration affect the production of cell mass and ethanol as well as endogenous metabolism. At high glucose concentrations, increases in oxygen concentration produced very small effects while at low glucose concentrations the oxygen effect was maximal. (auth)

3110 (UCRL—52000-75-9, pp 17-19) **Health and environmental effects of methanol as an automotive fuel.** Sep 1975.

In Lawrence Livermore Laboratory energy and technology review.

As an outgrowth of studies on methanol production from coal, a preliminary evaluation was made of the environmental and health effects that would result from using methanol as a transportation fuel. Available data indicate that the total photochemical reactivity of methanol exhaust is less than that of gasoline exhaust, hence its contribution to photochemical smog should be less. Unlike gasoline, methanol does not yield aromatic hydrocarbons, some of which are carcinogenic. It does not require the addition of aromatic hydrocarbons or lead to boost its octane rating. Also, the synthesis process for methanol results in a sulfur-free product, thus eliminating the hazards of sulfuric acid emissions. Further study is needed on the quantity of methanol likely to be released into the environment by spills, leaks, evaporation, and the increased nontransportation uses of a product so readily available. In particular, the effects of methanol on terrestrial and aquatic ecosystems need to be thoroughly investigated. (auth)

3111 **Economics of the production of liquid fuel and fertilizer by the fixation of atmospheric carbon and nitrogen using nuclear power.** Baron, S. (Burns and Roe, Inc., Oradell, NJ); Steinberg, M. pp 842-848 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The economics of using reactor power during off-peak period for the production of H_2 and fixation of C to produce methanol and the fixation of N_2 for the production of NH_3 are reviewed to show that it is economically feasible with the current prices of fossil fuels. The incremental energy costs for synthesis processes are summarized. Methanol and ammonia production and economics are analyzed. An additional economic advantage would be the possible production of single cell protein. (JSR)

SOLAR ENERGY

3112 (SAND—75-0388) **Brief description of SOLSYS: Energy System Simulation Computer Program.** Edenburn, M.W.; Grandjean, N.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 22p. Dep. NTIS $4.00.

Program (SOLSYS) is used primarily to simulate the transient performance of solar energy systems. The program consists of a component subroutine library, an information subroutine library, a control-component subroutine library, and an executive program. Component subroutines model the performance of fluid-handling components which can be connected to construct almost any desired energy system. The component subroutine library presently contains 21 subroutines modeling collectors, storage units, power-generation cycles, transmission and distribution hardware, heat exchangers, house equipment, and auxiliary energy components. Some components are modeled very accurately and others use simple energy-conservation models. Information subroutines supply time-dependent information such as insolation data, weather data, heating requirements, air-conditioning requirements, hot water requirements, and electrical requirements to the program. Control-component subroutines model components which control temperatures in the system and components which switch a fluid flow between fluid channels when switching is necessary. The executive program handles input and output and calls on subroutines in the appropriate order. (auth)

RESOURCES AND AVAILABILITY

HEAT STORAGE AND REJECTION

3113 (ANL—75-65) **Analysis of a system to thermally dissociate water using a semi-permeable membrane.** Ford, N.C. Jr. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-eng-38. 23p. Dep. NTIS $4.00.

A scheme using oxygen and hydrogen permeable membranes to thermally dissociate water into hydrogen and oxygen in order to provide for the storage and transportation of thermal energy is described and analyzed in terms of presently available materials. While the process is potentially very efficient, the membranes required to separate the hydrogen and oxygen are not stable at sufficiently high temperatures. It is concluded that a high temperature hydrogen permeable membrane must be discovered before further work is warranted. The rare earth-palladium compounds may have the desired characteristics. (auth)

SOLAR ENERGY CONVERSION

3114 **Reaction of tris(bipyridine)ruthenium(III) with hydroxide and its application in a solar energy storage system.** Creutz, C.; Sutin, N. (Brookhaven National Lab., Upton, NY). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 8, 2858-2862(Aug 1975).

Irradiation of $Ru(bipy)_3^{2+}$ (bipy = 2,2'-bipyridine) with light below 560 nm results in the formation of a charge-transfer excited state potentially capable of reducing water to dihydrogen with concomitant production of $Ru(bipy)_3^{3+}$. The latter may be reduced by hydroxide $Ru(bipy)_3^{3+} + OH^- = Ru(bipy)_3^{2+} + 1/4O_2 + 1/2H_2O$ to form dioxygen and regenerate the starting complex. The use of these reactions in a cell designed to bring about the photochemical decomposition of water is proposed. (W.O.M.)

PHOTOVOLTAIC CONVERSION

3115 (N—75-16085) **Test report SEPS solar array root section model.** (Lockheed Missiles and Space Co., Sunnyvale, Calif. (USA)). 6 Dec 1974. Contract NAS8-30315. 50p. (NASA-CR—1206060; LMSC-D—384268). NTIS $3.75.

The fabrication and test of a solar array functional root section model to verify preliminary array design concepts is presented. The root section model is full scale width and contains a model array blanket. The blanket contains 1/8 live electrical modules and the remainder contains solar cell mass simulators. A storable Astromast is used for array blanket extension and retraction. The model component and system assembly hardware, tests, and test results are described. (auth)

3116 (N—75-17406) **Spacecraft attitude control for a solar electric geosynchronous transfer mission.** Leroy, B.E.; Regetz, J.D. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1975. 14p. (NASA-TM-X—71669; E—8256). NTIS $3.25.

From 11. electric propulsion conference; New Orleans, LA, USA (19 Mar 1975).

A study of the Attitude Control System (ACS) is made for a solar electric propulsion geosynchronous transfer mission. The basic mission considered is spacecraft injection into a low altitude, inclined orbit followed by low thrust orbit changing to achieve geosynchronous orbit. Because of the extended thrusting time, the mission performance is a strong function of the attitude control system. Two attitude control system design options for an example mission evolve from consideration of the spacecraft configuration, the environmental disturbances, and the probable ACS modes of operation. The impact of these design options on other spacecraft subsystems is discussed. The factors which must be considered in determining the ACS actuation and sensing subsystems are discussed. The effects of the actuation and sensing subsystems on the mission performance are also considered. (auth)

3117 (N—75-20865) **Development of a high efficiency thin silicon solar cell. Quarterly progress report.** Lindmayer, J. (Solarex Corp., Rockville, Md. (USA)). Feb 1975. Contract NAS7-100. 30p. (NASA-CR—142577). NTIS $3.75.

Progress is reported in an attempt to realize higher specific power output and radiation resistance from thin solar cells for space applications. The efforts applied to establishing the technological base for fabricating high efficiency thin solar cells are described. Progress is characterized by continuous improvements in all parameters of the space cell. (auth)

3118 (N—75-20866) **Inversion layer solar cell fabrication and evaluation. Final report.** Call, R.L. (Arizona Univ., Tucson (USA). Dept. of Electrical Engineering). Dec 1974. Contract NAS7-100. 91p. (NASA-CR—142573). NTIS $4.75.

Inversion layer solar cells were fabricated by etching through the diffused layer on p-type silicon wafers in a comb-like contact pattern. The charge separation comes from an induced p-n junction at the surface. The inverted surface is caused by a layer of transparent material applied to the surface that either contains free positive ions or that creates donor states at the interface. Cells are increased from 3 ma (1 sub sc) to 100 ma by application of sodium silicate. The action is unstable, however, and decays. Nonmesa contaminated oxide cells were fabricated with short circuit currents of o ver 100 ma measured in the sun. Cells of this type have demonstrated stability. (auth)

3119 (N—75-22900) **Photovoltaic cell array. Patent application.** Eliason, J.T. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). 25 Apr 1975. 9p. (NASA-Case-MFS—22458-1; SN—671458). NTIS $3.25.

A construction technique for making high density solar cell arrays at lowered costs is presented. Closely spaced filaments of silicon are prepared to have a continuous layer-type semiconductor junction formed by creating an internal p-type conductivity region and outer N-type conductivity region. Electrical output connections are made to the P and N layer regions by means of P bus members and N bus members. The filaments of silicon and connecting buses are appropriatly woven to form what is regarded as a solar cell blanket wih an effective density of 100-1,000 photocells per square inch. (STAR)

3120 (NASA-CR—134740) **Development of processing procedures for advanced silicon solar cells.** Scott-Monck, J.A.; Stella, P.M.; Avery, J.E. (Heliotek, Sylmar, Calif. (USA)). Jan 1975. Contract NAS3-17350. vp. NTIS.

Ten ohm-cm silicon solar cells 0.2 mm thick, were produced with short circuit current efficiencies up to thirteen percent and using a combination of recent technical advances. The cells were fabricated in conventional and wraparound contact configurations. Improvement in cell collection efficiency from both the short and long wavelengths region of the solar spectrum was obtained by coupling a shallow junction and an optically transparent antireflection coating with back surface field technology. Both boron diffusion and aluminium alloying techniques were evaluated for forming back surface field cells. The latter method is less complicated and is compatible with wraparound cell processing. (WDM)

3121 (NASA-CR—141325) **Inversion layer solar cell fabrication and evaluation.** Call, R.L. (Arizona Univ., Tucson (USA)). Jul 1974. Contract JPL-953785. vp. NTIS.

Inversion layer solar cells have been fabricated by etching through the diffused layer on P-type silicon wafers in a comb-like contact pattern. The charge separation comes from an induced p-n junction at the surface. This inverted surface is caused by a layer of transparent material that either contains free positive ions or creates donor states at the interface. Cells have increased from 3 ma to 100 ma short-circuit current by application of sodium silicate. The action is unstable, however, and decays with time. (WDM)

3122 (TID—26879) **Interim solar cell testing procedures for terrestrial applications.** Brandhorst, H.; Hickey, J.; Curtis, H.; Ralph, E. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center; Energy Research and Development Administration, Washington, D.C. (USA)). Jul 1975. 18p. Dep. NTIS $4.50.

A Terrestrial Photovoltaic Workshop under the joint sponsorship of ERDA and NASA was held at the NASA Lewis Research Center in March 1975. The workshop was divided into three separate sessions: (1) Solar Intensity and Spectrum Conditions for Terrestrial Photovoltaics; (2) Terrestrial Sunlight Simulation; and (3) Methodology for Measurements and Calibration of Solar Cells. A broad spectrum of short papers was presented; then the attendees addressed key questions in the workshop sessions. The separate sessions were held concurrently. This report presents an interim draft of procedures for testing solar cells for terrestrial applications that resulted from the workshop sessions. A final version of the test procedures manual is planned for the summer of 1976. (auth)

3123 **Auger analysis of silicon thin films deposited on carbon at high temperatures.** Chang, C.A.; Siekhaus, W.J. (Univ. of California, Berkeley). *J. Appl. Phys.*; **46**: No. 8, 3402-3407(Aug 1975).

Silicon films (2000 to 3000 A thick) were vacuum deposited onto pyrolytic graphite, extruded graphite, and glassy carbon at 1150 to 1200°C to test the possibility of using carbon as a substrate in thin-film silicon solar cells. The distribution of silicon and carbon in the carbon-silicon interface was studied using Auger spectroscopic depth profiling. The results showed that, for all substrates, carbon diffused deeply into silicon films, and for all substrates except glassy carbon, silicon also diffused deeply into carbon. In both cases, silicon carbide is formed. Several methods to build diffusion barriers were tested. A diffusion mechanism is proposed according to which silicon atoms first form a carbide layer with the surface carbon atoms, whereafter cracking of the carbon lattice and diffusion of silicon through the carbide layers into the carbon substrates follow. This mechanism is shown to explain very well the dependence of the measured silicon and carbon contents on the structure of the carbon substrates used for depositions. (auth)

3124 **Polycrystalline silicon solar cells on low cost foreign substrates.** Chu, T.L. (Southern Methodist Univ., Dallas); Lien, J.C.; Mollenkopf, H.C.; Chu, S.C.; Heizer, K.W.; Voltmer, F.W.; Wakefield, G.F. *Sol. Energy;* **17**: No. 4, 229-235(Sep 1975).

The use of polycrystalline silicon layers on low-cost substrates is a promising approach for the fabrication of low-cost solar cells. Using low-carbon steel and graphite as substrates, solar cell structures have been deposited by the thermal decomposition of silane and appropriate dopants. Steel was selected as a substrate on the sole basis of its low cost. However, steel and silicon are not compatible in their properties, and an interlayer of a diffusion barrier, such as borosilicate, must be used to minimize the diffusion of iron from the substrate into the deposit. The deposited silicon on borosilicate/steel substrates is polycrystalline with a grain size of 1 to 5 μm, depending on deposition conditions. p-n junction solar cells were found to have low open-circuit voltages and poor current-voltage characteristics, and Schottky-barrier solar cells were found to show negligible photovoltages. Graphite is more compatible with silicon in properties than steel, and silicon deposited on graphite substrates shows considerably better microstructures. A number of solar cells, 2.5 X 2.5 cm in area, have been fabricated from n^+-silicon/p-silicon/p^+-silicon/graphite structures. The best cell to date had a V/sub OC/ of 0.35 V and an AMO efficiency of 1.5 percent (no antireflection coating). This type of solar cell is very promising because of the simplicity in fabrication. (auth)

SOLAR THERMAL POWER PLANTS

3125 (PB—231115) **Solar thermal electric power systems. Annual progress report, 1 May—31 December 1973.** (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.; Westinghouse Electric Corp., Boulder, Colo. (USA). Georesearch Lab.). Jan 1974. 288p. NTIS $6.75.

The objective of this research program is to develop design parameters for solar thermal electric power systems that can pro-

vide lowest cost electric power. Parametric performance and cost models are being developed for subsystems such as the concentrator, flat plate collector, absorber-heat transfer, heat transport, heat storage, heat engine, and cooling tower. Cost optimization methods are being developed, which can be used to select cost effective subsystem units, subsystem groups and to optimize the entire system. Power systems of 3 to 100 MW capacity that can be utilized in electrical networks are being considered. (auth)

3126 (PB—235475) **Solar thermal electric power systems. Quarterly progress report No. 1, 1 January—30 April 1974.** (Colorado State Univ., Fort Collins (USA). Solar Energy Applications Lab.; Westinghouse Electric Corp., Boulder, Colo. (USA). Georesearch Lab.). Apr 1974. 177p. (NSF/RANN/SE/GI—37815/PR/74/1). NTIS $7.00.

Results of research to identify cost effective solar thermal electric power systems are given. Parametric performance and cost models were developed for concentrating collector, heat transport, and heat storage subsystems. Dynamic programming methods to select optimal subsystems and the solar thermal power systems are discussed. Power systems larger than 3 MW capacity that can be used in electrical networks are considered. (auth)

3127 (SLA—74-0132) **Rankine cycle working fluids for solar-to-electrical energy conversion. Final report.** Miller, D.R. (Monsanto Research Corp., St. Louis, Mo. (USA)). Jan 1974. Contract AT(29-1)-789. 71p. (MRC-SL—399). Dep. NTIS $6.75.

For Sandia Labs., Albuquerque, NM.

Sandia's Solar Community Study includes a proposal to use a Rankine cycle to convert a part of the solar energy into electrical power. The desired characteristics of the energy conversion system are given and the objectives of this report were to identify and thermodynamically characterize ten candidate working fluids for such applications. Candidates were to include three fluids of special interest to Sandia: toluene, chlorobenzene, and isobutane. Water was to be used as a comparison working fluid in Rankine cycle calculations. (auth)

3128 Update on the solar power system and component research program. Blake, F.A. (Martin Marietta Aerospace, Denver); Walton, J.D. *Sol. Energy;* **17**: No. 4, 213-219(Sep 1975).

Preliminary design configuration features of the point design 100-MWe solar energy conversion power system and user applications for the direct solar/hydroelectric installations are presented. The 405-acre (1.64 km^2) plant consists of a central power station surrounded by eight solar energy collection/concentration/conversion fields, which supply the required 1250 psi, 950°F (510°C) superheated steam for turbine generator operation. Boiler and superheater assemblies in each field are mounted on a 400-ft (121.9-m) high tower at the center of the southern border of the field. In each field, 1840 mirrors perform the collection/concentration function with a single reflection of the solar energy. The user application analysis examines the potential contribution of the 11-MWe plant to a southwestern utility based on the local demand and solar weather patterns of 1973. An overview of the component testing for a bench model boiler/superheater and associated turbine generator being planned in collaboration with the Centre Nationale de la Recherche Scientifique solar energy laboratory at Odeillo, France is presented. (auth)

3129 Methodology for selecting optimal components for solar thermal energy systems: application to power generation. Duff, W.S. (Colorado State Univ., Ft. Collins). *Sol. Energy;* **17**: No. 4, 245-254(Sep 1975).

A methodology is presented for determining the minimum-cost design for a solar thermal energy system. This approach builds up the minimum-cost system by adding one subsystem at a time until the desired system has been synthesized. At each step in the optimization procedure the intermediate system could be applied to an appropriate end use to find the minimum-cost design for that system. For example, a minimum-cost solar furnace could be designed. This systems optimization approach has two principal advantages over approaches that have traditionally been used for solar thermal energy systems. First a vastly greater number of designs can be considered, and second, simplification of cost and performance models is not required. Cost and performance models may be in any form including tables or equations that must be solved implicitly. An example of the systems optimization of the concentrator and absorber-heat exchanger subsystems is included, and the application of this approach to power generation is discussed. (auth)

TOWER FOCUS POWER PLANTS

3130 Studies of the direct input of solar energy to a fossil-fueled central station steam power plant. Zoschak, R.J.; Wu, S.F. (Res. Div., Foster Wheeler Corp., Livingston, NJ). *Sol. Energy;* **17**: No. 5, 297-305(Nov 1975).

From International Solar Energy Society's US Section Meeting; Fort Collins, CO (Aug 1974).

Seven possible methods of absorbing solar energy as direct thermal input to an 800 MW, fossil-fueled, central station steam power plant have been studied. Irrespective of method, the solar heat is first collected by an array of flat mirrors and concentrated on a tower-mounted absorber where it is transferred into the power cycle. The heat absorbing methods studied were heating of feed-water, evaporation of water, superheating of steam, combined evaporation and superheating, reheating of steam, air preheating, and combined air preheating and feedwater heating. Factors considered were relative capital cost, energy conversion efficiency and complexity of design, operation and control. Combined evaporation and superheating proved to be the preferred method because of its high utilization of solar energy, relatively low indicated capital cost and only moderate complexity in design, operation and control. Feedwater heating also has very desirable capital cost, design and operating aspects, but suffers from the drawback that over 30 percent of the solar energy absorbed is, in effect, lost because of degradation of the steam cycle efficiency. (auth)

OCEAN THERMAL GRADIENT POWER PLANTS

3131 (NSF/RANN/SE/GI-C—937/FR/75/1(Vol.2)) **Ocean thermal energy conversion (OTEC) power plant technical and economic feasibility. Vol. II. Supporting data.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif. (USA)). 12 Apr 1975. 818p. (LMSC-D—056566(Vol.2)). NTIS $21.25.

A 9-month study of the practicality of generating electrical power at competitive busbar prices by using the solar energy that is stored as a thermal gradient in the world's oceans was completed. This volume is a compendium of the most significant detailed data and engineering analyses developed during the course of this brief, but intensive, study of a complex problem. (WDM)

3132 (NSF/RANN/SE/GI-C—937/FR/75/1(Vol.1)) **Ocean thermal energy conversion (OTEC) power plant technical and economic feasibility. Vol. I. Technical report.** (Lockheed Missiles and Space Co., Inc., Sunnyvale, Calif. (USA)). 12 Apr 1975. 194p. (LMSC-D—056566(Vol.1)). NTIS $7.50.

A study was completed of the practicality of generating electrical power at competitive busbar prices by using the solar energy that is stored as a thermal gradient in the world's oceans. This two-volume final report describes the manner in which the study was accomplished and the results that were achieved. Because of the importance of national energy policy decisions, and in view of the magnitude of the prospective investment involved, it was imperative that study results be highly credible. This required equal treatment of advantages and disadvantages, and the use of conservative industry data and estimates for projecting costs of contruction and operation. Although the study was not directed to meet a specific timetable of power plant availability, the national energy situation provided strong motivation to define a program that converged rapidly, but logically, on a plant design with controlled risk. A baseline power plant design concept was developed from components, materials, and processes that are currently in use in the power and construction industries. It served to identify all the potential problem areas, to provide a solid basis for cost estimating, and to aid in assessing the impact of more advanced technology. The baseline power plant consists of a semisubmersible spar-type platform, four power modules, a 1,000-ft-long telescoping cold-water pipe, and a single-pointmoor. It is capable of generating 160 MW(e) net and can be deployed in tropical waters at depths ranging from 2,500 to 20,000 ft. Each power module is self-contained and separable from the platform, and has its own sea-water circulating pumps, heat exchangers of the shell-and-tube type, turbine, generator, buoyancy control, and auxiliary equipment. (auth)

SOLAR RADIATION UTILIZATION

3133 (MTR—6739(Vol.1)) **Japanese/United States symposium on solar energy systems, Washington, D.C., June 3—5, 1974. Volume 1. Summary of proceedings .** (MITRE Corp., McLean, Va. (USA)). Jun 1974. 52p. Dep. NTIS $5.75.

This document is a summary of the proceedings of the Japanese/U.S. Symposium on Solar Energy Systems held in the Board Room of the National Science Foundation on June 3, 4, and 5, 1974 under the sponsorship of the NSF Research Applied to National Needs (RANN) Program. This symposium, for which The MITRE Corporation served as Program Coordinator, provided a forum to review current and proposed work on solar energy technology in Japan and the U.S. and to suggest suitable areas for coordinated research by the two countries. (auth)

3134 (MTR—6739(Vol.2)) **Japanese/United States symposium on solar energy systems, Washington, D.C., June 3—5, 1974. Volume II. Summaries of technical presentations.** (MITRE Corp., McLean, Va. (USA)). Jun 1974. 147p. Dep. NTIS $10.50.

This volume contains summaries of the technical presentations made by the speakers at the meetings held on June 3 to June 5, 1974. (WDM)

3135 (N—75-22746) **Solar powered pump. Patent application.** Kirsten, C.C. (National Aeronautics and Space Administration, Pasadena, Calif. (USA)). 9 Apr 1975. Contract NAS7-100. 19p. (NASA-Case-NPO—13567-1; SN—566493). NTIS $3.25.

A low cost water pump suitable for use in agricultural irrigation in underdeveloped regions is disclosed. The pump is adopted to use unconcentrated sunlight as a source of energy and atmospheric air as a working fluid for intermittently delivering a stream of water from a given source. (STAR)

SPACE HEATING AND AIR CONDITIONING

3136 (AAS—75-105) **Temperature control for solar heating and cooling of buildings.** Winn, C.B.; Hull, D. (American Astronautical Society, Tarzana, Calif.). 1975. 36p. (CONF-750739—1). Dep. NTIS $5.00.

From 66. annual conference of international district heating association; Skytop, Pennsylvania, USA (23 Jun 1975).

The Energy Research and Development Administration has recently called for the development of control systems that allow the user to regulate the amount of solar and auxiliary supplied energy in the thermal control of buildings, the development of control systems that respond to variations in the use patterns of buildings on seasonal, daily, hourly, and instantaneous bases, and the development of controls based on algorithms that minimize the total use of energy in heating and cooling buildings. This paper addresses each of these problem areas. First, a discussion of a control system presently being employed in existing solar energy buildings is presented. This controller is then discussed in terms of the above mentioned problem areas. Next, several heuristic control strategies are considered and examined in terms of their performance. Finally, a discussion of optimal control strategies is presented and compared with the controllers previously examined. (auth)

3137 (AAS—75-108) **Application of optimization techniques to solar heating and cooling.** Anderson, L.B.; Rauch, H.E. (American Astronautical Society, Tarzana, Calif.). 1975. 35p. (CONF-750739—5). American Astronautical Society, Tarzana, CA.

From 66. annual conference of international district heating association; Skytop, Pennsylvania, USA (23 Jun 1975).

Lockheed is designing a solar heating and cooling system for the city of Santa Clara's new community center. Water heated by solar collectors is used to heat the building in winter and cool the building in summer (using absorption cycle water chillers). This paper shows how optimization techniques can be applied to the operation of a solar driven heating and cooling system such as the Santa Clara facility and outlines practical problems encountered in the design. In the optimization problem the loss function includes not only the cost of heating and cooling but also the equivalent cost of discomfort involved when the temperature is not held at its desired value. The discomfort is assumed to be a quadratic function of temperature. An interesting feature of the resulting optimization problem is a region of singular control because the Hamiltonian is linear in the heating and cooling variable. An optimal strategy is derived and numerical examples are presented to show the desired building temperatures throughout the day which minimize the sum of energy consumption and the discomfort factor. Additional analysis derives the necessary conditions for the optimal operation of the separate components involved in a solar driven heating and cooling system. (auth)

3138 (COO—2702-1) **Solar powered desiccant air conditioning system. Phase II. Quarterly progress report.** Lunde, P.J. (Center for the Environment and Man, Inc., Hartford, Conn. (USA)). Aug 1975. 8p. Dep. NTIS $4.50.

Computer model development, component and system design, and test bed design for the solar desiccant air conditioning with silica gel are briefly discussed. (WDM)

3139 (N—75-22903) **Solar residential heating and cooling system development test program.** Humphries, W.R.; Melton, D.E. (National Aeronautics and Space Administration, Huntsville, Ala. (USA). George C. Marshall Space Flight Center). Sep 1974. 129p. (NASA-TM-X—64924). NTIS $5.75.

A solar heating and cooling system is described, which was installed in a stimulated home at Marshall Space Flight Center. Performance data are provided for the checkout and initial operational phase for key subsystems and for the total system. Valuable information was obtained with regard to operation of a solar cooling system during the first summer of operation. Areas where improvements and modifications are required to optimize such a system are discussed. (auth)

3140 **COOLING BY SOLAR HEAT.** Weinstein, A.; Chen, C.S. Paper 75-609. New York; United States of America (USA); American Institute of Aeronautics and Astronautics (1975). 8p.

From Solar energy for earth conference; Los Angeles, California, USA (21 Apr 1975).

A large-scale solar system for the heating and cooling of the George A. Towns elementary school in Atlanta, Georgia has been designed and is under construction. The system, utilizing all commercially available components, features a 100-ton absorption cooling machine, 10,000 square feet of solar collectors and 13,000 square feet of reflective surfaces to augment the insolation collected, and a closed loop collector drain-down system with added corrosion protection. It is scheduled to begin operation in April to May of 1975 and is expected to provide for more than 60 percent of the cooling and heating requirement for the school. Material and labor costs for the system are still high, especially as a result of very sharp increases in conventional component prices. (auth)

3141 (PB—235424) **Solar heating and cooling of buildings (Phase 0). Volume III. Appendices.** (TRW Systems, Redondo Beach, Calif. (USA)). 31 May 1974. 365p. NTIS $8.00.

This volume includes additional detailed data to supplement Volume II -- Final Report. The appendices have the following titles: System Development Requirements-Climatic Regions; System Performance Requirements; System Definition-Analytical Model; Advanced System Concepts-High Temperature Evacuated Solar Collector; Capture Potential Assessment-Methodology, Energy Supply/Demand, Population and Building Projections, Qualitative Factors Affecting the Capture Potential, and Actual Market Capture; Implications from Heat Pump Industry: Heat Pumps and Their Uses in Solar Heating and Cooling Systems; Systems Definition-Space Cooling Systems; Convection and Radiation Suppression with Honeycomb structures; and High Temperature Solar Collector Systems. (auth)

3142 (PB—235428) **Solar heating and cooling of buildings (Phase 0). Final report. Volume II. Appendices A-N.** (Westinghouse Electric Corp., Baltimore, Md. (USA)). May 1974. 400p. NTIS $8.25.

This volume contains 14 appendices to a study of the technical, economic, social, environmental, and institutional factors affecting the feasibility of using solar energy for heating and cooling of buildings. Titles of the appendices are: Building and Usage Selection; Solar Collector and Solar Heating/Cooling; Future Fuel Prices; Westinghouse Building Code; Changes in Standard Building Practice, Insulation and Materials, Structures; Thermal and Noise Comfort in Buildings; Residential and Nonresidential Building Design; Reliability and Maintainability; Safety and Code Aspects for Solar Systems; Solar Cooling by Adsorption Air-Conditioners; Informational Material Development; Control Requirements; A State-of-the-Art Review of Solar Heating and Cooling Systems and Subsystems; and Absorption Air-Conditioning. (auth)

3143 (PB—235432) **Solar heating and cooling of buildings (Phase 0), feasibility and planning study. Final report. Volume II. Technical report.** (General Electric Co., Philadelphia, Pa. (USA). Space Div.). May 1974. 474p. (74-SD-4219(Vol.2)). NTIS $9.75.

The results of a study to assess the feasibility and practical merits of the use of solar energy to heat and cool buildings and provide hot water are reported. Included are descriptions of program methodology, development of requirements, systems definition, assessment of capture potential, social and environmental study, preliminary cost study, recommendations for proof of concept experiments, and development of plans for phase 1, phase 2, and utilization. (auth)

3144 (PB—235433) **Solar heating and cooling of buildings (phase 0). Feasibility and planning study. Final report. Volume III, book 1. Appendix A, task 1. Development of requirements. Appendix B, task 2. Systems definition.** (General Electric Co., Philadelphia, Pa. (USA). Space Div.). May 1974. 354p. (74-SD-4219(Vol.3)(Bk.1)). NTIS $8.00.

This volume contains Appendices A and B to the study of solar heating and cooling of buildings. Appendix A is concerned with the development of requirements and contains sections on a collector solar flux computer program, a preliminary solar heating and cooling screening model, a peak design loads computation program, and building parameters used to develop heating and cooling loads. Appendix B is concerned with systems definition, including descriptions of models for heat pumps, solar absorption cooling systems, solar Rankine systems, nocturnal cooling, solar

collector simulation, skytherm heating and cooling systems, and collector performance. Also discussed are thermal energy storage, heat recovery HVAC systems, on-going research pertinent to solar heating and cooling of buildings, system performance data plots, and climatological optimization of solar collectors. (auth)

3145 (PB—235483) **Proceedings of the solar heating and cooling for buildings workshop, Washington, DC, March 21—23, 1973. Part II. Panel sessions, March 23.** Allen, R. (Maryland Univ., College Park (USA). Dept. of Mechanical Engineering). Apr 1974. 67p. NTIS $3.75.

The meeting was called in recognition of the pressing need for exchange of information among researchers in this rapidly expanding field. Papers were presented under the following subject headings: Solar building technology; NSF solar heating and cooling for buildings program; Industrial activities; Related building activities. (auth)

3146 (SAND—75-5272) **Low cost solar augmented heat pump system for residential heating and cooling.** Alcone, J.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 28p. (CONF-751106—11). Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

The analysis and design of a low cost solar collector/heat storage system configured to take advantage of the characteristics of conventional air-to-air heat pumps is presented. The dynamical interaction of the various system components is examined and the resulting design constraints are given. The system as proposed eliminates the collector costs associated with conventional solar systems while requiring an increase in the volume required for thermal storage of 50 percent. (auth)

3147 **Solar heating for Atlanta school.** Duncan, R.T. Jr. (Westinghouse Electric Corp., Baltimore); Doering, E.R. *ASHRAE (Am. Soc. Heat. Refrig. Air-Cond. Eng.) J.*; **17**: No. 7, 35-39(Jul 1975).

This experiment in the utilization of solar energy for both heating and cooling is expected to yield substantive contributions to the technology. Topics discussed include solar collector array, collector mounting, absorption air conditioning, thermal storage, thermal fluid flow design, and piping. (WDM)

3148 **Solar heat pump.** Eibling, J.A.; Frieling, D.H. (Battelle Columbus Labs., Columbus, OH). *Sol. Energy;* **17**: No. 5, 313-15(Nov 1975).

From International Solar Energy Society's US Section Meeting; Fort Collins, CO (Aug 1974).

A solar-powered heat pump concept is described based on patented ideas developed at Battelle. A program to develop the concept is currently being funded by the Energy Research and Development Administration (ERDA). The basic idea was conceived about two years ago after extensive studies on rotary-vane refrigeration compressors had been conducted for several of the leading refrigerator manufacturers. The first application was for the Air Force on high-speed fuel and hydraulic pumps. Later the American Gas Association funded a program to study using the unit in a natural-gas-operated air conditioner. In 1973 this research was extended and applied to a solar heat pump. The ERDA project is a design study of the heat pump compressor/expander unit. The solar collector, the heat storage component, and other auxiliaries have been left to separate studies. Ultimately an entire system will be assembled and evaluated. (auth)

WATER HEATING

3149 **Solar-assisted gas-energy water-heating feasibility for apartments.** Davis, E.S. (California Inst. of Tech., Pasadena). *Sol. Energy;* **17**: No. 4, 237-243(Sep 1975).

Studies of residential energy use, solar-energy technology for buildings, and the requirements for implementing technology in the housing industry led to a project to develop a solar water heater for apartments. A design study for a specific apartment was used to establish a solar water-heater cost model which is based on plumbing contractor bids and manufacturer estimates. The cost model was used to size the system to minimize the annualized cost of hot water. The annualized cost of solar-asisted gas-energy water heating is found to be less expensive than electric water heating but more expensive than gas water heating. The feasibility of a natural gas utility supplying the auxiliary fuel is evaluated. It is estimated that gas-utilizing companies will find it profitable to offer solar water heating as part of a total energy service option or on a lease basis when the price of new base-load supplies of natural gas reaches $2.50 to $3.00 per 10^6 Btu. (auth)

SOLAR COLLECTORS AND CONCENTRATORS

3150 (N—74-34675) **Solar simulator mirror refurbishment. Final report, 27 June 1972—30 September 1974.** Leverton, W.R. (Electro-Optical Systems, Inc., Pasadena, Calif. (USA)). 18 Sep 1974. Contract NAS9-12960. 43p. (NASA-CR—140298). NTIS $5.25.

Solar simulator mirrors were refurbished. Two different refurbishment methods were employed. In the first, the electroformed mirror replica was removed from the casting and replaced with a new mirror replica. In the second, only the aluminized surface, with its protective overcoat, was removed from the mirror and replaced after cleaning of the nickel surface. (auth)

3151 (N—75-17784) **Collection and concentration of solar energy using Fresnel type lenses. Final summary report.** Wilson, R.F. (Texas Southern Univ., Houston (USA)). 7 Feb 1975. Contract NsG-9009. 13p. (NASA-CR—142194). NTIS $3.25.

The efficiency of collecting solar energy using a Fresnel type lens was measured for two different collectors. A flow collector utilizes the temperature difference and heat capacity in water measurements to determine the amount of absorbed energy retained from sun rays passing through the Fresnel lens. A static collector is a hollow copper box filled with vegetable heating oil for absorption of focused solar radiation. (STAR)

3152 (N—75-18719) **Solar energy concentrator system for crystal growth and zone refining in space. Final report.** McDermit, J.H. (Lockheed Missiles and Space Co., Huntsville, Ala. (USA)). Feb 1975. Contract NAS8-30268. 104p. (NASA-CR—120623; LMSC-HREC-TR-D—390666). NTIS $5.25.

The technological feasibility of using solar concentrators for crystal growth and zone refining in space has been performed. Previous studies of space-deployed solar concentrators were reviewed for their applicability to materials processing and a new state-of-the-art concentrator-receiver radiation analysis was developed. The radiation analysis is in the form of a general purpose computer program. It was concluded from this effort that the technology for fabricating, orbiting and deploying large solar concentrators has been developed. It was also concluded that the technological feasibility of space processing materials in the focal region of a solar concentrator depends primarily on two factors: (1) the ability of a solar concentrator to provide sufficient thermal energy for the process and (2) the ability of a solar concentrator to provide a thermal environment that is conductive to the processes of interest. The analysis indicate that solar concentrators can satisfactorily provide both of these factors. (auth)

3153 (N—75-18720) **Status of the NASA-Lewis flat-plate collector tests with a solar simulator.** Simon, F.F. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 20p. (NASA-TM-X—71658). NTIS $3.25.

From Workshop on solar collectors for heating and cooling of buildings; New York, New York, USA (21 Nov 1974).

Simulator test results of 15 collector types are presented. Collectors are given performance ratings according to their use for pool heating, hot water, absorption A/C or heating, and solar Rankine machines. Collectors found to be good performers in the above categories, except for pool heating, were a black nickel coated, 2 glass collector, and a black paint 2 glass collector containing a mylar honeycomb. For pool heating, a black paint, one glass collector was found to be the best performer. Collector performance parameters of 5 collector types were determined to aid in explaining the factors that govern performance. The two factors that had the greatest effect on collector performance were the collector heat loss and the coating absorptivity. (auth)

3154 (N—75-21794) **Solar collector performance evaluated outdoors at NASA-Lewis Research Center.** Vernon, R.W. (National Aeronautics and Space Administration, Cleveland, Ohio (USA). Lewis Research Center). 1974. 7p. (NASA-TM-X—71689). NTIS $3.25.

From Workshop on solar collectors for heating and cooling of buildings; New York, New York, USA (21 Nov 1974).

An outdoor facility constructed to evaluate solar collector performance for conditions that would be encountered by collectors if they were incorporated in a solar heating/cooling system is described. Preliminary performance data is presented. (auth)

3155 (NTIS/PS—75/347) **Solar energy collectors and concentrators. A bibliography with abstracts. Period covered: 1964—December 1974.** Hundemann, A.S. (National Technical Information Service, Springfield, Va. (USA)). Feb 1975. 57p. NTIS $25.00.

Presented are 57 abstracts dealing with solar energy collectors and concentrators, including heliostats. Abstracts cover flat

plate collectors, shallow ponds, linear focused collectors, absorbers, and collectors and concentrators as they relate to solar heating and cooling of buildings and solar thermal electric power systems. Concentration of solar energy for spacecraft application is excluded except in those cases in which the technology may have terrestrial application. (auth)

3156 (SAND—75-0358) **Effects of defocus on a cylindrical fresnel lens.** Robertson, C.E.; Banker, J.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 9p. Dep. NTIS $4.50.

This report presents a graphic demonstration of image defocus and movement resulting from the curvature of field of the uncorrected lens and also illustrates the effects of refocusing by changing the lens-image plane distance. (auth)

3157 **Principles of cylindrical concentrators for solar energy.** Winston, R. (Argonne National Lab., IL); Hinterberger, H. *Sol. Energy;* **17**: No. 4, 255-258(Sep 1975).

Ideal cylindrical light collectors are trough-like reflecting wall light channels of a specific shape which concentrate radiant energy by the maximum amount allowed by phase space conservation. A principle is proposed for maximally concentrating radiation onto a tube receiver of general shape. Employing this principle, a general prescription is given for designing concentrators appropriate to such tube receivers. This design may have advantages for solar-thermal and photovoltaic applications. (auth)

3158 **Effect of outdoor aging on acrylic sheet.** Rainhart, L.G.; Schimmel, W.P. Jr. (Sandia Labs., Albuquerque, NM). *Sol. Energy;* **17**: No. 4, 259-264(Sep 1975).

One of the prime contenders for solar reflectors or concentrators is acrylic plastic. Other than the basic requirement of being a highly efficient reflector or transmitter of the solar spectrum, it must offer excellent long-term weatherability with minimum cost. The weatherability of acrylic polymers, although known to be good compared to other polymers, has been an unknown with regard to actual exposure data in the southwestern United States, where the potential is high for solar energy installations. This report is a compilation of data obtained from an acrylic panel that has been exposed for over 17 years in the semi-arid desert terrain south of Albuquerque, New Mexico. A comparison is made with unexposed material having a very similar polymer structure. In general, chemical changes are not detectable while mechanical response shows some evidence of embrittlement. In spite of these, the decrease in optical transmission is surprisingly low. The as-recovered material (with dust-eroded surface) had an integrated or total transmittance which was 10 percent less than the control material, based on a solar radiation spectrum. In order to isolate the degradation loss due to change in the basic polymer, a polished specimen of aged material was tested and showed only a 3 percent drop in transmission across the solar spectrum. It appears reasonable that this low loss could be duplicated in a solar reflector provided the mirror is coated with an abrasion-resistant glass resin system. (auth)

GEOTHERMAL ENERGY

3159 (ERDA—86) **Definition report. Geothermal Energy Research, Development and Demonstration Program.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Geothermal Energy). Oct 1975. vp. Dep. NTIS $5.45.

This report has been prepared in response to the requirements of the Geothermal Energy Research, Development, and Demonstration Act of 1974, Public Law 93-410. The report is devoted to the broad definition of the Geothermal Energy RD and D Program involving the activities of ERDA and other cognizant Federal agencies. The purpose of this document is to delineate the major thrusts associated with an overall Federal effort. A more detailed definition of the ERDA Geothermal Energy Program was published in "A National Plan for Energy Research, Development and Demonstration: Creating Energy Choices for the Future," (ERDA-48) in June 1975 and will be updated on an annual basis. The goal of this Geothermal Energy RD and D Program is to work with industry to provide the Nation with an acceptable option which, if exercised, would permit the timely exploitation of our geothermal resources. Federal efforts which will assist industry in accelerating geothermal development have been defined in the areas of resource assessment; research, development and demonstration in areas of high technical risk; information dissemination and loan guaranties to reduce financial risk; and assistance in the reduction and removal of institutional impediments to healthy industry growth. Integral to the Federal program is the continued development and adoption of appropriate measures necessary for protection of the environment. Program planning for this Geothermal Energy Research, Development and Demonstration (RD and D) Program has been carried out as a coordinated interagency effort and within the overall framework of the National Plan for Energy RD and D. (from Foreward and Summary)

3160 **SDG and E: ERDA joint venture.** *Geotherm. Energy Mag.;* **3**: No. 9, 6-10(Sep 1975).

The historical and technical background of the San Diego Gas and Electric Company's (SDG and E) geothermal program leading to the joint venture between SDG and E and ERDA is given. The Niland test work, Herber field test work, and the Niland geothermal test facility are outlined. The major problems and the status and prospective of geothermal electric power generation are also outlined. (LBS)

RESOURCES AND AVAILABILITY

USA

3161 (ANCR—1213) **Geological aspects of an assessment of the national potential for non-electrical utilization of geothermal resources.** Hollenbaugh, K.M.; Nichols, C.R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Jun 1975. Contract AT(10-1)-1505. 251p. Dep. NTIS $7.60.

This report presents exhaustive data on the potential sources and uses of geothermal water particularly in the Western third of the United States. This data includes the currently known or expected location, quality, quantity, and temperatures of geothermal sources. Included are discussions of the more important sources. Recommendations are made relative to potential utilization of these sources. In addition, suggestions are presented for the scientific evaluation of these and other potential geothermal sources. (auth)

3162 **Development of the Nation's geothermal energy resources.** Kruger, P. (Energy Research and Development Administration, Washington, DC). *Geotherm. Energy Mag.;* **3**: No. 8, 25-27(Aug 1975).

From 2. energy technology conference; Washington, DC (12 May 1975).

A review is given of the national effort to develop geothermal energy resources as a significant contribution to the energy supply. Three parallel tasks required to meet this objective are discussed: (1) the discovery, proving, and extraction of geothermal resources to provide a significant supply of hydrothermal fluids for direct utilization and to produce more than 5×10^{12} kWh of electricity over the amortization period of the investment in resource development and power plant construction, (2) the technology to convert the resources as found in its various natural forms and qualities into electric and thermal power production, and (3) the removal of unnecessary institutional constraints to the rapid development of a cost effective and environmentally-acceptable industry. (LBS)

SITE GEOLOGY, HYDROLOGY, AND METEOROLOGY

NON-USA

3163 (UCRL-Trans—10842) **Region 50°-51° n lat./48°-49° e long. from Pulkovo.** Gornostaev, N.N. Translated from *Izv. Sib. Otd. Geol. Kom.;* **5**: No. 2, 1-45(1925). 89p. Dep. NTIS $7.50.

A geologic survey was made of the region bounded by 50 and 51° north latitude and 48 and 49° east longitude, an area in the U.S.S.R. covering about 7500 km². Information on the tectonics, petrography, and minerals are reported. The structure of the region is extremely complex, and much of the locality was hidden under various loose formations, making the survey difficult. (PMA)

GEOTHERMAL EXPLORATION AND EXPLORATION TECHNOLOGY

GEOCHEMICAL TECHNIQUES AND SURVEYS

3164 (LBL—3232) **Radioactivity of geothermal systems.** Wollenberg, H.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-ENG-48. 28p. (CONF-750525—12). Dep. NTIS $4.50.

From 2. United Nations symposium on the development and uses of geothermal resources; San Francisco, California, USA (20 May 1975).

An examination of hot spring waters in Nevada indicates the presence of radium-226 and radon-222, in varying abundances, in spring systems where $CaCO_3$ is the predominant material being deposited. Systems where silica predominates are relatively low in radioactivity. At a hot spring site in north-central Nevada where $CaCO_3$ predominates, gamma-ray levels from 0.25 to 0.5 milliroentgens per hour were measured over an enclosed warm pool. At other systems where SiO_2 predominates, gamma exposure rates are nearly two orders of magnitude lower. The emanation of ^{222}Rn from thermalized fault zones is a possible exploration tool in locating a geothermal resource. An alpha-track detector survey within a potential resource area indicates anomalously high Rn associated with hot pools, but a rather featureless Rn pattern in valley alluvium away from the hot springs. Results of studies combining neutron activation analyses of hot and cold waters in a region, and radiometric analyses of the waters and hot spring deposits, suggest that uranium entering a geothermal system is localized at depth by (1) a reducing environment afforded by H_2S and (2) precipitation of uranyl carbonate. The presence of the U at depth is indicated at the surface by its daughter products, Ra and Rn, in hot spring waters and deposits. Along with these geochemical aspects, an understanding of the radioactivity of a geothermal resource is necessary to evaluate the environmental impact of its possible future development. (auth)

EXPLORATORY DRILLING

3165 (IDO—10062) **Raft River Geothermal Exploratory Hole No. 1 (RRGE-1). Completion report.** (Reynolds Electrical and Engineering Co., Inc., Las Vegas, Nev. (USA)). Oct 1975. Contract E(26-1)-410. 45p. (NVO—410-30). Dep. NTIS $4.00.

Raft River Geothermal Exploratory Hole No. 1 (RRGE-1) is an exploratory hole drilled to a depth of 5,000 feet in intruded quartz monzonite basement rock of the Raft River valley of southeastern Idaho. The goal of the Raft River Geothermal R and D program is to determine the feasibility of developing and utilizing medium temperature (300°F) geothermal resources for power generation and nonelectrical applications. This well was drilled to obtain geological information and evaluate the deep geothermal reservoir system. This report describes the drilling and completion of RRGE-1 and includes the daily drilling reports, drill bit records, descriptions of the casing, cementing, logging and coring programs, and the containment techniques employed on RRGE-1. A subsequent report, IDO 10063, will describe the planning, technology, and testing of RRGE-1. (auth)

GEOTHERMAL POWER PLANTS

POWER CONVERSION SYSTEMS

3166 (CONF-750525—14) **Moderate temperature utilization project in the Raft River Valley.** Kunze, J.F.; Miller, L.G.; Whitbeck, J.F. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 25p. Dep. NTIS $4.50.

From 2. United Nations symposium on the development and uses of geothermal resources; San Francisco, California, USA (20 May 1975).

The volume of geothermal waters and the energy utilizable per temperature increment undoubtedly increases rapidly with decreasing temperature. Despite the theoretical attractiveness of moderate temperature (100° to 150°C) reservoirs, the commercial technology for economically generating electricity from such waters does not exist today. A research project to develop more economical methods of utilizing such resources has been undertaken by the Energy Research and Development Agency. The Raft river Valley in Southern Idaho, typical of the Basin and Range Valley situation in the U. S., was selected; extensive geophysical work followed and deep exploratory drilling commenced in early 1975. Design of a power conversion system has examined both multiple flash steam cycles and a variety of binary fluid system, both boiling cycles and supercritical cycles. Power outputs vary from 6 to 11 watts per kg/hr of geothermal fluid. Selected cycles have received detailed conceptual design sufficient to obtain a cost estimate. Low initial temperatures (150°C) require transfer of large quantities of fluid to the plant and to reinjection sites. Thus reservoir management for long-life is a major technical aspect of such a power plant. Results show a double flash steam system is more economical than a binary system, at least in modules of 100 MW or less with fluid at 150°C. Development of more efficient and less costly heat exchangers such as fluidized bed and direct contact, immiscible fluid devices is in progress.If developed, the binary system would become more attractive vis-a-vis steam. results to date show that the fluidized bed system effectively inhibits scale formation. (auth)

3167 (LA-UR—75-1463) **Geothermal energy.** Tester, J.W.; Milora, S.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 18p. (CONF-750733—1). Dep. NTIS $4.00.

From Energy sources of the future meeting; Oak Ridge, Tennessee, USA (7 Jul 1975).

The discussions cover six areas of geothermal resource utilization: (1) concept and potential of the resource; (2) natural geothermal systems; (3) artifically stimulated, dry hot rock geothermal systems; (4) energy utilization alternatives; (5) power cycle thermodynamics; and (6) power cycle economics. A summary is also given of the preliminary results from a joint study between Oak Ridge National Laboratory and Los Alamos Scientific Laboratory. The study is directed toward developing thermodynamic and economic design criteria applicable to geothermal electric power systems. (LBS)

3168 (UCRL—52000-75-8) **Lawrence Livermore Laboratory energy and technology review.** Carr, R.B.; Barnett, J.M.; Berlo, R.C.; McCaleb, C.S.; Prono, J.K. (eds.). (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.00.

Separate abstracts were prepared for four sections of this report, two of which appear in Nuclear Science Abstracts and two in ERDA Research Abstracts. (CH)

3169 (UCRL—52000-75-8, pp 1-8) **Advanced energy systems.** Aug 1975.

In Lawrence Livermore Laboratory energy and technology review.

Techniques and equipment being developed at LLL for recovering geothermal energy from subterranean hot water deposits by the total flow process are described. Some recent engineering accomplishments are reported: fabrication of a total flow turbine and partial characterization of a converging-diverging nozzle to expand the wellhead fluid. The data indicate nozzle velocity coefficients thus exceed 0.9. (LBS)

GEOTHERMAL ENGINEERING

DRILLING TECHNIQUES AND WELL HARDWARE

3170 **Geothermal energy pump thrust balance apparatus.** Govindarajan, R.; Lobach, J.L.; Nichols, K.E. (to Sperry Rand Corp.). US Patent 3,905,196. 16 Sep 1975. Filed date 15 Jul 1974. 20p.

A geothermal energy transfer and utilization system makes use of thermal energy stored in hot solute-bearing well water to generate super-heated steam from an injected flow of clean water; the super-heated steam is then used for operation of a turbine-driven pump at the well bottom for pumping the hot solute-bearing water at high pressure and in liquid state to the earth's surface. There, it is used by transfer of its heat content to a closed-loop boiler-turbine-alternator combination for the generation of electrical or other power . Cooled, clean water is regenerated by the surface-located system for re-injection into the deep well and the residual concentrated solute-bearing water is pumped back into the earth. Significant axial thrust is developed in the support bearing system of the steam turbine driven hot water pump because of the considerable pressure head rise generated by the hot water pump, the axial thrust being proportional to the hot water pump discharge pressure. According to the invention, a balancing thrust is developed that is also proportional to pump discharge pressure, so that the net thrust is minimized over a range of speed and hot water flow conditions. (auth)

ENERGY UTILIZATION

3171 (ANCR—1256) **Feasibility review for geothermal conversion of existing H and V systems on the Boise geothermal space heating project.** Torgerson, L.D.; Richardson, A.S. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Sep 1975. Contract E(10-1)-1375. 66p. Dep. NTIS $5.45.

A pilot demonstration project to be located in the city of Boise, Idaho has been initiated to heat by geothermal water a number of public buildings. This report presents the findings of a study which was made to review the feasibility of converting the various public building heating systems to allow the use of geothermal water at a temperature of at least 170°F as a heat source. (auth)

3172 (CONF-750525—15) **Non-electric utilization project: Boise, Idaho.** Kunze, J.F.; Richardson, A.S.; Hollenbaugh, K.M.; Nichols, C.R.; Mink, L.L. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 17p. Dep. NTIS $4.50.

From 2. United Nations symposium on the development and uses of geothermal resources; San Francisco, California, USA (20 May 1975).

The utilization of geothermal waters for space heating is being designed for the State and Federal office building complex in Boise, Idaho under the geothermal program of the Energy Research and Development Agency. A detailed geological and engineering feasibility study and engineering design of the system is now being conducted. The system is to supply a total heat load of 30 MW to the State Capitol Bldg., several large office buildings, the Federal building, and several buildings on the university campus. Source temperature is approximately 75°C, and the necessary fluid will be supplied by approximately 10 wells yielding 300 liter/sec. Transmission distances will not exceed 5 Km. Two wells operating from the reservoir for some 80 years have been supplying 100 liters/sec for a smaller residential heating system. Appropriate disposal of the discharge fluid from the center of a metropolitan area represents the major problem. Re-injection is but one of the alternatives. The method eventually selected must meet strict environmental requirements. Furthermore, the system must prove economical with respect to current heating system fuel costs of approximately $1/MW-hour. Conversion of existing heating systems to utilize source temperatures substantially less than present boiler temperatures requires a variety of engineering design changes, all within the constraints for equipment from space and utility tunnels. Again, the costs of such alterations must be kept to a minimum so that entire system costs can be amortized with fuel cost savings over the 3500°C-days of annual heat requirement. (auth)

GEOTHERMAL DATA AND THEORY

3173 (LA—5956-PR) **Solid earth geosciences research activities at LASL July 1—December 31, 1974.** McGetchin, T.R. (comp.). (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1975. Contract W-7405-eng-36. 93p. Dep. NTIS $5.45.

The present major efforts of LASL in energy related research are the dry hot rock geothermal energy project and the rock melting subterrene, an electrically powered, high-temperature experimental drilling technique. The primary interests of the geoscience group are igneous geology and solid earth geophysics--the origin, emplacement, and chemical evolution of plutons and volcanoes, and the nature of heat and mass transfer in the earth's interior. The research program includes seismology, rock mechanics, experimental high-pressure geophysics, experimental geochemistry, observational petrology and geochemistry, field geology, and modeling by theoretical numerical and physical simulation. Research activities in support of geothermal energy include: (1) geochemical and petrological investigations of drill cores; (2) physical and mechanical properties of the cores, in situ and in the laboratory, (3) seismology, (4) experimental and numerical investigation of the chemical interaction of granite and hot aqueous solutions, and (5) field and laboratory investigations of heat flow and the thermal properties of the cores. Investigations of solution geochemistry have proved to be especially interesting because they have possible applications in solution mining, suggesting coupled geothermal energy and mineral extraction operations. (LBS)

WIND ENERGY

WIND ENERGY ENGINEERING

3174 (UCRL-Trans—10721) **Models for wind profiles over rough and smooth surfaces.** Roth, R. Translated from *Beitr. Phys. Atmos.*; **45**: 277-304(1972). 48p. Dep. NTIS $5.50.

Models for turbulent boundary layers over smooth and rough surfaces are presented. The basic principles of both models are that, starting from artifically chosen initial values for the spectra of turbulent energy, turbulence and mean wind profile are allowed to develop together until the steady state is reached. Both models assume fully developed turbulence i.e. high Reynolds numbers. Heisenberg's theory for the transfer of turbulent energy within the spectrum is used to calculate spectral densities of turbulent energy. The assumptions of constant shearing stress with height adiabatic structure of the boundary layer, and horizontal homogeneity are made. As a result the model for the rough surface shows the well-known logarithmic wind profile with a von Karman constant of 0.395. Over the smooth surface the wind profile agrees very well with empirical profiles; in particular, the height of the viscous sublayer is well reproduced. The dependence of the results on the assumptions made in the models is discussed in detail. 34 references. (auth)

3175 **Nonlinear stress analysis of vertical-axis wind turbine blades.** Weingarten, L.I.; Nickell, R.E. (Sandia Labs, Albuquerque, NM). *J. Eng. Ind.*; **97**: No. 4, 1234-1237(Nov 1975).

From American Society of Mechanical Engineers technical conference; Washington, DC, USA (17 Sep 1975).

A Darrieus-type vertical-axis wind turbine has been proposed as an alternate to conventional horizontal axis, propeller-type machines. An advantage is that the blades will be primarily in tension, thus making for a more efficient design. In connection with its vertical-axis wind turbine program, Sandia Laboratories has developed the "troposkien" (Greek for turning rope) shape for the blade design. The prototype blade shape is similar to that of the troposkien, but more easily manufactured. The effect on the stress distribution of this alternate blade shape is investigated. Analytical models of the blades were constructed using a general purpose, nonlinear, dynamic finite element structural code. This code accounts for the large deflection of the various blade shapes through incremental applications of angular velocity. (auth)

TURBINE DESIGN AND OPERATION

3176 (SAND—75-5512) **Material and manufacturing considerations for vertical-axis wind turbines.** Weingarten, L.I.; Feltz, L.V. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 14p. (CONF-751005—7). Dep. NTIS $4.00.

From 7. national SAMPE technical conference; Albuquerque, New Mexico, USA (14 Oct 1975).

Since 1973, Sandia Laboratories has been studying wind turbines and, in particular, Darrieus-type vertical-axis wind turbines (VAWT) for use in remote areas and as a fuel saver for electrical power grid application. The VAWT being investigated at Sandia employs curved blades which minimize bending stresses. The tension-only stresses in the blades provide a variety of manufactured methods to be considered. Mathematical procedures that are being developed for structural analysis are discussed. 7 references. (auth)

POWER CONVERSION SYSTEMS

3177 (NP—20408) **Program solicitation: research on wind energy conversion systems.** (National Science Foundation, Washington, D.C. (USA). Div. of Advanced Energy and Research and Technology). 17 Jul 1974. 15p. Dep. NTIS $4.00.

The Research Applications Directorate of the National Science Foundation intends to provide approximately $3,000,000 for research on advanced systems, subsystems and associated problem areas related to advancing the capability of extracting useful energy from the wind. Proposals are being sought in six categories: wind energy mission analysis; applications of wind energy systems; wind characteristics; subsystems and components research and technology; advanced or innovative system concepts; and advanced farm and rural use systems. Information on research categories and requirements for submitting proposals are described. (auth)

ELECTRIC POWER ENGINEERING

POWER GENERATION

POWER PLANT COMPONENTS

3178 (RISO-M—1759) **Dynamics and control of a simplified once-through boiler.** Lind, M. (Danish Atomic Energy Commission, Risoe. Research Establishment). Mar 1975. 113p. Dep. NTIS (US Sales Only) $8.75.

A dynamic point model of a simplified once-through boiler was developed. The model comprises economiser, evaporator, burner and feedwater pump dynamics. The reheater and superheaters are excluded, but the influence of the superheater volume on the pressure dynamics is included. The model is nonlinear and has six state-variables. A linearized model valid for perturbations around an operating point was derived from the nonlinear model, and computer programs were developed for computation of state-space and transfer matrices in selected operating points. The properties of the linearized boiler model at full power conditions as a

multivariable control object was studied. On the basis of these considerations some decoupling control systems are proposed and compared by frequency analytical methods and simulation on an analogue computer. (auth)

ENVIRONMENTAL ASPECTS

NOXIOUS GAS CONTROL

3179 (UCRL—76794) **Trace contaminants from coal-fired power plants.** Ragaini, R.C.; Ondov, J.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Sep 1975. 18p. (CONF-750963—2). Dep. NTIS $4.00.

From IEEE international conference on environmental sensing and assessment; Las Vegas, Nevada, USA (15 Sep 1975).

The Lawrence Livermore Laboratory program to evaluate the trace elements in stack emissions from coal-fired power plants is described. Stack sampling and analysis of fly ash at a modern, western power plant is discussed. Significant sources of error in the use of cascade impactors are examined. Scanning Electron Microscope techniques are shown to be essential for accurate sizing of stack particles sampled with cascade impactors. Particle size distributions for volatile and nonvolatile trace elements are reported. Comparison of the trace element enrichment factors with those of an eastern coal-fired power plant shows significant differences. (auth)

POWER TRANSMISSION AND DISTRIBUTION

3180 (ORNL—4919) **Effects of nuclear electromagnetic pulse (EMP) on synchronous stability of the electric power system.** Manweiler, R.W. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 91p. Dep. NTIS $5.45.

The effects of a nuclear electromagnetic pulse (EMP) on the synchronous stability of the electric power transmission and distribution systems are evaluated. The various modes of coupling of EMP to the power system are briefly discussed, with particular emphasis on those perturbations affecting the synchronous stability of the transmission system. A brief review of the fundamental concepts of the stability problem is given, with a discussion of the general characteristics of transient analysis. A model is developed to represent single sets as well as repetitive sets of multiple faults on the distribution systems, as might be produced by EMP. The results of many numerical stability calculations are presented to illustrate the transmission system's response from different types of perturbations. The important parameters of both multiple and repetitive faults are studied, including the dependence of the response on the size of the perturbed area, the fault density, and the effective impedance between the fault location and the transmission system. Both major load reduction and the effect of the opening of tie lines at the time of perturbation are also studied. We conclude that there is a high probability that EMP can induce perturbations on the distribution networks causing a large portion of the transmission network in the perturbed area to lose synchronism. The result would be an immediate and massive power failure. (auth)

AC SYSTEMS, EHV AND UHV

3181 (EPRI-TD—3) **Transmission and Distribution Division. Progress report.** (Electric Power Research Inst., Palo Alto, Calif. (USA)). Sep 1975. 33p. NTIS $5.00.

Brief discussions are given for the following areas: (1) 1976 program plan, (2) future planning methods in distribution, (3) new test facilities, (4) superconductivity: worldwide research, and (5) insulating oils research. (MOW)

3182 (ORNL-tr—4023) **Characteristics and applications of vacuum switchgears.** Matsuda, A.; Takada, A.; Hirai, K.; Ota, A.;. Translated by H. Kubota from *Natl. Tech. Rep.* (*Matsushita Electr. Ind. Co., Osaka*); **18**: No. 5, 526-548(1972). 52p. Dep. NTIS $5.75.

The vacuum switchgears are suitable for high voltage switching devices since vacuum is extraordinarily efficient as a switching medium and the interrupting arc is completely enveloped. Vacuum switches were developed with ceramic valves and, these days, they are used for most of the commonly encountered duties of distribution lines or load control equipment. The advantages of vacuum switchgears are these (1) space saving, (2) safety improvement, and (3) reduced maintenance. Utilization of vacuum switches has ideally improved the reliability of switching devices for distribution lines and load control devices. This paper discusses vacuum switchgears in this field, with the proper application of vacuum switches. (auth)

3183 **Resonant transmission-line configurations for optimum FM detection of vibration using capacitance transducers.** Pare, V.K. (Oak Ridge National Lab., TN). *J. Acoust. Soc. Am.*; **58**: No. 2, 490-493(Aug 1975).

Resonant transmission-line configurations are described which give maximum frequency modulation amplitude when modulated by a small terminating capacitance. If the termination is a capacitive vibration transducer, there results a wide-band, absolutely calibrated system which can detect small vibration amplitudes in a severe environment. (auth)

DC SYSTEMS

3184 (LA—6053-PR) **USERDA Division of Electric Energy Systems dc superconducting power transmission line project at LASL, January 1—March 31, 1975.** Keller, W.E.; Taylor, R.D. (comps.). (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. 23p. Dep. NTIS $4.00.

The ninth progress report of the Los Alamos Scientific Laboratory dc Superconducting Power Transmission Line (SPTL) Development Project covers the period January 1 to March 31, 1975. The measured magnetic field profile near a superconducting tape carrying a current is explained by a simple model of the current distribution. The propagation velocity of a normal zone in a stabilized superconductor was measured and found to depend on the direction of the current flow. Some efficiency and cost factors of several possible designs for a dc SPTL are compared with transmission line alternatives. (auth)

NUCLEAR POWER PLANTS

3185 (CONF-750411—82) **Decommissioning in the mature nuclear power industry.** Anderson, F.H.; Slansky, C.M. (Allied Chemical Corp., Idaho Falls, Idaho (USA). Idaho Chemical Programs - Operations Office). 1975. 4p. Dep. NTIS $4.50.

From European nuclear conference; Paris, France (21 Apr 1975).

Procedures for decommissioning a nuclear power plant or a spent fuel reprocessing plant are described. (DCC)

3186 (KFK-EXT—8/75-2) **REGENT: seventh semiannual progress report, October 1974—March 1975.** Schlechtendahl, E.G. (comp.). (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Reaktorentwicklung). Aug 1975. 43p. (In German). Dep. NTIS (US Sales Only) $5.00.

The project REGENT(German acronym for CAD, Computer Aided Design) was started early 1972 by the Institut fuer Reaktorentwicklung. The seventh semiannual progress report summarizes the results achieved up to March 31, 1975, in particular with respect to the development of the REGENT system nucleus and its application for the first REGENT subsystems. The development of the REGENT nucleus and of a graphical subsystem has become a part of the project CAD since mid 1974. Other subsystems are being developed within the framework of the project PNS (Project Nuclear Safety). (auth)

3187 (ERDA-tr—78) **Engineering probability calculations in nuclear reactor design.** Klemin, A.I. 1973. Translation by W.J. Grimes of Inzhenerne veroyatnostne raschety pri proyektirovanii yadernykh reaktorov, Moscow, Atomizdat, 1973. 444p. Dep. NTIS $12.75.

The book is a manual to be used by designers, analysts, researchers, and production workers in solving the practical problems which arise at all stages in the construction of a nuclear reactor, using methods of the theory of probability and mathematical statistics. The book deals with problems relating to the following areas: quantitative evaluation of reliability and radiation safety of nuclear reactors, planning and analysis of the results of tests and experiments forming the basis of nuclear reactor design, estimation of the accuracy of computational characteristics, statistical analysis of the manufacturing accuracy of reactor structures, and choice of solutions under conditions of indeterminacy. 130 references. (auth)

3188 **Conference on nuclear power and applications in Latin America, September 28—October 1, 1975, Mexico City, Mexico.** Farmakes, R. (ed.). *Trans. Am. Nucl. Soc., Suppl.*; **21**: No. 2, Suppl., vp(1975).

From Nuclear power and applications in Latin America; Mexico City, Mexico (28 Sep 1975).

See CONF-750928—.

Forty-six papers covering the topics of nuclear power, the fuel cycle, and isotopes and radiation were presented. These

papers are all listed by title in NSA. Four papers are listed by title in ERA. (JWR)

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, BOILING WATER COOLED

3189 (CONF-750360—2) **Cracked pellet gap conductance model: comparison of FRAP-S calculations with measured fuel centerline temperatures.** MacDonald, P.E.; Broughton, J.M. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Mar 1975. Contract AT(10-1)-1375. 20p. Dep. NTIS $4.50.

From OECD halden reactor project conference; Geilo, Norway (17 Mar 1975).

Fuel pellets crack extensively upon irradiation due both to thermal stresses induced by power changes and at high burnup, to accumulation of gaseous fission products at grain boundaries. Therefore, the distance between the fuel and cladding will be circumferentially nonuniform; varying between that calculated for intact operating fuel pellets and essentially zero (fuel segments in contact with the cladding wall). A model for calculation of temperatures in cracked pellets is proposed wherein the effective fuel to cladding gap conductance is calculated by taking a zero pressure contact conductance in series with an annular gap conductance. Comparisons of predicted and measured fuel centerline temperatures at beginning of life and at extended burnup are presented in support of the model. 13 references. (auth)

3190 (CONF-750958—2) **Behavior of irradiated LWR fuel pellets during thermal transients.** Kelman, L.R.; Rest, J.; Seitz, M.G.; Gehl, S.M. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 3p. Dep. NTIS $4.00.

From 3. annual water reactor safety meeting; Washington, District of Columbia, USA (29 Sep 1975).

Prediction of the behavior of LWR fuel rods and fission products under off-normal and accident conditions requires a physically realistic description of fuel swelling and fission-product release that currently does not exist. To satisfy this need, a program was initiated at ANL approximately a year ago with the prime objective of developing a comprehensive computer-base model that describes the release of fission products as a function of thermal transients anticipated in hypothetical accident situations. This model will be incorporated into ANC's FRAP accident-analysis code system. The analytical effort is supported by data developed from characterization of irradiated LWR fuel and from out-of-reactor transient heating tests of irradiated LWR fuel under conditions that simulate hypothetical LWR accidents. (auth)

3191 (GEAP—20950) **Advanced steam cycles for light water reactors. Final report.** Mitchell, R.C. (General Electric Co., San Jose, Calif. (USA)). Jul 1975. Contract E(04-3)-189. vp. Dep. NTIS $7.60.

An appraisal of the potential of adding superheat to improve the overall LWR plant cycle performance is presented. The study assesses the economic and technical problems associated with the addition of approximately 500°F of superheat to raise the steam temperature to 1000°F. The practicality of adding either nuclear or fossil superheat to LWR's is reviewed. The General Electric Company Boiling Water Reactor (BWR) model 238-732 (BWR/6) is chosen as the LWR starting point for this evaluation. The steam conditions of BWR/6 are representative of LWR's. The results of the fossil superheat portion of the evaluation are considered directly applicable to all LWR's. The review of nuclear superheat shows that, in spite of the potential of a nuclear superheater to provide a substantial boost to the LWR cycle efficiency, nuclear superheat offers little promise of development at this time. There are difficult technical problems to resolve in the areas of superheat fuel design and emergency core cooling. The absence of a developed high integrity, high temperature fuel for operation in the steam/water environment is fundamental to this conclusion. Fossil superheat offers the potential opportunity to utilize fossil fuel supplies more efficiently than in any other mode of central station power generation presently available. Fossil superheat topping cycles evaluated included atmospheric fluidized beds (AFB), pressurized fluidized beds, pressurized furnaces, conventional furnaces, and combined gas/steam turbine cycles. The use of an AFB is proposed as the preferred superheat furnace. Fossil superheat provides a cycle efficiency improvement for the LWR of two percentage points, reduces heat rejection by 15 percent per kWe generated, increases plant electrical output by 54 percent, and burns coal with an incremental net efficiency of approximately 40 percent. This compares with a net efficiency of 36—37 percent which might be achieved with an all-fluidized bed fossil superheat plant design. (auth)

3192 **Review of advanced steam cycles for light water reactors.** McNelly, M.J.; Mitchell, R.C. (General Electric Co., San Jose, CA). Contract AT(04-3)-189. pp 295-307 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The status of superheating for LWR steam cycles is reviewed. (JWR)

POWER REACTORS, NON-BREEDING, LIGHT-WATER MODERATED, NON-BOILING WATER COOLED

3193 **Analysis of neutron-density oscillations resulting from core barrel motion in a PWR nuclear power plant.** Fry, D.N.; Kryter, R.C.; Robinson, J.C. (Oak Ridge National Lab., TN). *Ann. Nucl. Energy;* **2**: 341-351(1975).

Neutron noise signatures were obtained on August 3, 1973, that were due to abnormal movement of the core barrel at the Palisades Nuclear Plant. Frequency spectra, rms noise, and amplitude probability density were recorded as sensed by ex-core and in-core neutron detectors. These signatures will serve as reference data for future studies of core-barrel motion at the Palisades plant. Also, the results are presented in units that should make them useful for noise diagnosis in other pressurized water reactors. (auth)

POWER REACTORS, NON-BREEDING, GRAPHITE MODERATED

3194 (GA-A—13487) **Startup physics tests at Fort St. Vrain.** Ross, S.R.; Brown, J.R.; Nirschl, R.J. (General Atomic Co., San Diego, Calif. (USA)). 20 May 1975. Contract AT(04-3)-633. 30p. (CONF-750607—33). Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

The results of the physics tests performed to date during the startup testing program are presented, and measured results are compared with predicted values. (auth)

3195 (GA-A—13524) **Mechanical properties of graphite for high-temperature gas-cooled reactors: a review.** Price, R.J. (General Atomic Co., San Diego, Calif. (USA)). 22 Sep 1975. Contract E(04-3)-167. vp. Dep. NTIS $5.45.

Experimental data on the mechanical properties of reactor graphites (excluding irradiation creep and fatigue) under High-Temperature Gas-Cooled Reactor (HTGR) conditions are reviewed. Based on an assessment of the literature, recommendations are made for design-basis values for the elastic properties and strength of irradiated graphite, and failure criteria are suggested for particular loading conditions. 78 references. (auth)

3196 (GA-A—13592) **HTGR fuels and core development program. Quarterly progress report for the period ending August 31, 1975.** (General Atomic Co., San Diego, Calif. (USA)). 30 Sep 1975. Contract AT(04-3)-167. 275p. Dep. NTIS $7.60.

Studies of reactions between core materials and coolant impurities, basic fission product transport mechanisms, core graphite development and testing, the development and testing of recyclable fuel systems, and physics and fuel management studies are described. Materials studies include irradiation capsule tests of both fuel and graphite. Experimental procedures and results are discussed and, where appropriate, the data are presented in tables, graphs, and photographs. (auth)

POWER REACTORS, BREEDING

3197 (AI-ERDA—13153) **Fuels, materials, and control rod development programs. Annual technical progress report, government fiscal year 1975.** (Atomics International Div., Canoga Park, Calif. (USA)). 1975. Contract AT(04-3)-824. 47p. AT.

Progress is reported in the following areas: (1) irradiation damage studies in cladding and core structural materials, (2) helium generation studies in reactor materials, and (3) control absorber heating experiments and calculations. (JWR)

3198 (ANL—75-16) **Flow-induced vibration in LMFBR steam generators: a state-of-the-art review.** Shin, Y.S.; Wambsganss, M.W. (Argonne National Lab., Ill. (USA)). May 1975. Contract W-31-109-Eng-38. 89p. Dep. NTIS $5.45.

This state-of-the-art review identifies and discusses existing methods of flow-induced vibration analysis applicable to steam generators, their limitations, and base-technology needs. Also included are discussions of five different LMFBR steam-generator configurations and important design considerations, failure experiences, possible flow-induced excitation mechanisms, vibration testing, and available methods of vibration analysis. The objectives are to aid LMFBR steam-generator designers in making the best possible evaluation of potential vibration in steam-generator internals, and to provide the basis for development of design guidelines to avoid detrimental flow-induced vibration. (auth)

3199 (ANL—75-53) **Chemical interaction between fuel and cladding in stainless-clad fast reactor fuels.** Fee, D.C.; Johnson, I.; Johnson, C.E. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 46p. AT.

The nature of the chemical interaction between mixed oxide fuel and the cladding of fast reactor fuel pins is reviewed. The irradiation of a fuel pin is discussed in terms of four processes. Processes that occur early in the life of the fuel pin are the development of a temperature gradient and the restructuring of the fuel. Processes that occur later in the life of the fuel pin are the buildup of fission products, which affects the oxygen potential, and the migration of fission products. The chemistry of corrosive attack processes is discussed in terms of both in-pile and out-of-pile observations. Current models of cladding attack are evaluated. The elimination of cladding attack through the use of getters to control the oxygen potential is discussed. (auth)

3200 (ANL-CT—76-18) **Investigation of LMFBR outlet plenum thermal-hydraulic behavior during reactor scram transients.** Lorenz, J.J.; Carlson, R.D.; Howard, P.A. (Argonne National Lab., Ill. (USA)). Sep 1975. 118p. AT.

An experimental and analytical investigation was conducted to study mixing in LMFBR outlet plenums. Tests were performed with water and sodium using 1/15-scale models of CRBRP and FFTF upper plenums. Froude number (ratio of buoyant to inertial forces) similitude was satisfied in order to properly establish the density differences which lead to outlet plenum flow stratification. It was found that during all normal scram runs the lower velocity, denser fluid had insufficient inertia upon entering the plenum to overcome the negatively buoyant forces and stratification ensued. Instead of penetrating well into the plenum and mixing with the fluid therein, the incoming jet was deflected downward and outward toward the exit nozzles in a mushroom-shaped stratified flow pattern. But despite dramatic flow stratification, exit nozzle transients were relatively modest for all geometries except CRBRP without chimneys. For CRBRP it was shown that the inlet chimney structure significantly mitigates flow stratification and improves plenum mixing. In constant flow runs, the torroidal flow pattern was maintained and 100 percent mixing was experienced for both sodium and water. By comparing 1/15-scale ANL and 0.55-scale B-CL water data for FFTF geometry it was found that plenum scale size is not extremely important. Fluid property effects were assessed by comparing 1/15-scale ANL sodium and water data. For both FFTF and CRBRP geometry it was shown that water and sodium transients were in fairly good agreement; thus water can be used to adequately simulate sodium. In view of these observations it was concluded that for the purpose of obtaining engineering design data relating to LMFBR outlet plenums, small scale water tests can be used to simulate full scale sodium behavior. (auth)

3201 (ANL-CT—76-19) **Stability of cavitation bubbles and cavitation inception in water and in liquid sodium.** Cha, Y.S. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 40p. AT.

Cavitation inception is studied from the point of view of the stability of cavitation bubbles. A potential energy is defined and shown to be identical to the Helmholtz free energy of a thermodynamic system. The equation of motion of the boundary of a cavitation bubble is derived by employing the Lagrangian formulation. The stability criteria of a cavitation bubble is shown to be similar to that of the theory of small oscillations in classical mechanics, i.e., the bubble is in a state of stable equilibrium if the potential energy is a local minimum and the bubble is in a state of unstable equilibrium if the potential energy is a local maximum. The stability characteristics of a gas bubble are found to be quite different from those of a vapor bubble. The critical pressure of a cavitation bubble is very close to the vapor pressure of the liquid if the gas content in the bubble is relatively large and it decreases as the gas content in the bubble is decreased. The difference between cavitation inception in water and in liquid sodium is not significant provided that both liquids contain gas nuclei that are relatively large in size (with radius in the order of approximately 10^{-4} IN). For degassed liquids, the difference can be significant. (auth)

3202 (CONF-750303—80) **Evaluated decay-scheme data for the ILRR program.** Helmer, R.G.; Greenwood, R.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 4p. Dep. NTIS $4.00.

From Proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

The half-lives and γ-ray intensities associated with radioactive decay have been evaluated for nuclides of interest to the Interlaboratory LMFBR Reaction Rate program. The results indicate that for most of the isotopes the decay parameters are known sufficiently well to meet the ILRR goals of $2^1/_2$ or 5 percent accuracy in reaction rate measurements. (auth)

3203 (CONF-750804—11) **Preliminary thermal-hydraulic design and predicted performance of the Clinch River Breeder Reactor core.** Carelli, M.D.. Markley, R.A. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1975. Contract AT(11-1)-2395. 18p. Dep. NTIS $4.00.

From Conference on heat transfer; San Francisco, California, USA (11 Aug 1975).

The preliminary thermofluids design of the core assemblies of the Clinch River Breeder Reactor Plant (CRBRP) is presented along with the predicted performance for various plant operating conditions. The selected radial blanket assemblies shuffling scheme and the new approach adopted for fuel and blanket assemblies orificing is discussed. Relevant thermofluids parameters (assembly flow rate and mixed mean outlet temperature, fuel rod temperatures, fission gas plenum pressure, etc.) are presented. Highlights of a detailed uncertainties study performed are summarized. This preliminary analysis has shown that the CRBRP core behavior is compatible with design limits and requirements; future developments for a final analysis are outlined. (auth)

3204 (CONF-751036—2) **Results from the testing of high temperature neutron detectors in a liquid metal fast breeder reactor at temperatures up to 1000°F (538°C).** Yingling, G.E.; Popper, G.F. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 9p. Dep. NTIS $4.50.

From International standards association conference; Millwaukee, Wisconsin, USA (6 Oct 1975).

A summary is presented of results from the performance testing of two high temperature neutron fission counter-cable assemblies and a high temperature gamma compensated ionization chamber-cable assembly in a typical Liquid Metal Fast Breeder Reactor (LMFBR) nuclear environment at temperatures up to 1000°F (538°C). A brief description of the test program, instruments and facilities is also included. (auth)

3205 (CONF-751106—5) **Cesium vapor cycle for an advanced LMFBR.** Fraas, A.P. (Oak Ridge National Lab., Tenn. (USA)). 1975. 29p. Dep. NTIS $5.00.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

A review indicates that a cesium vapor topping cycle appears attractive for use in the intermediate fluid circuit of an advanced LMFBR designed for a reactor outlet temperature of 1250°F or more and would have the following advantages: (1) it would increase the thermal efficiency by about 5 to 10 points (from approximately 40 percent to approximately 45 to 50 percent) thus reducing the amount of waste heat rejected to the environment by 15 to 30 percent. (2) the higher thermal efficiency should reduce the overall capital cost of the reactor plant in dollars per kilowatt. (3) the cesium can be distilled out of the intermediate fluid circuit to leave it bone-dry, thus greatly reducing the time and cost of maintenance work (particularly for the steam generator). (4) the large volume and low pressure of the cesium vapor region in the cesium condenser-steam generator greatly reduces the magnitude of pressure fluctuations that might occur in the event of a leak in a steam generator tube, and the characteristics inherent in a condenser make it easy to design for rapid concentration of any noncondensibles that may form as a consequence of a steam leak into the cesium region so that a steam leak can be detected easily in the very early stages of its development. (auth)

3206 (GEAP—13825-13) **Instrumentation development thirteenth quarterly report, January—March 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). May 1975. Contract AT(04-3)-893. 36p. AT.

The development of instrumentation for surveillance of the core and in-vessel components of liquid metal fast breeder reactors is reviewed. Current development efforts are focused on high temperature neutron detectors and advanced signal transmission methods. 7 references. (auth)

3207 (GEAP—13993(Rev.1)) **PECS-II: a computer program for the probabilistic evaluation of fuel rod failure caused by fission**

gas pressure. Temme, M.I.; Atcheson, D.B.; Feerick, B.T. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 208p. AT.

The PECS-II (Probabilistic Evaluation of Cladding Stress) computer program is described, along with instructions for its use. Monte Carlo simulation is used to calculate probability distributions for LMFBR cladding failure caused by fission gas pressure. The entire reactor core is simulated by dividing the core into groups of fuel rods with similar operating conditions. Importance sampling is applied in order to reduce the number of Monte Carlo samples (and the cost) required for adequate estimation of low values of probability. PECS-II is operational on the Honeywell-6000 computer and the CDC-7600 computer. (auth)

3208 (GEAP—14031-3) **Core restraint engineering third quarterly report, February—April 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 22p. AT.

Core restraint system design requirements, subcomponents, and analytical methods in accordance with LMFBR Program Plant Task 6-216-1, 6-216-2, and 6-216-3, are presented. Progress during February, March, and April 1975 is described for subtasks related to withdrawal force testing, transient analysis, load pad and channel wall lateral limits, in-reactor load pad surveillance, and withdrawal force minimizer. (auth)

3209 (GEAP—14045-2) **Reliability program for shutdown heat removal. Second quarterly report, March—May 1975.** (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). 1975. Contract AT(04-3)-893. 50p. AT.

The objective of the LMFBR Shutdown Heat Removal (SHR) Reliability Program is to assess analytically and empirically the reliability of heat removal systems to remove heat from the reactor after scram or normal shutdown and to provide technology for assuring that reliability objectives are achieved. The reliability engineering tasks that this program encompasses can be categorized into four general groups (1) reliability analysis methods, goals, applications and criteria, (2) reliability assessments and related analyses, (3) SHR data collection and processing activities, and (4) reliability test program activities. LMFBR SHR reliability activities for the period beginning in March 1975 and ending in May 1975 are reported. Activities covered include completion of the Preliminary Reliability Report for LMFBR Heat Removal Systems, completion of the reliability program plan, and preparation of revisions to the LMFBR reliability manual. (auth)

3210 (GEAP—14051) **GRO-II: a simplified method for predicting mixed oxide fuel rod performance during normal operation.** Patel, M.; White, D.E. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 58p. AT.

GRO-II is a simplified one-dimensional structural analysis code which predicts the performance of mixed oxide fuel rods with primary emphasis on the cladding. The code computes the stresses, strains and cumulative thermal creep damage in the cladding using a simplified model of the fuel-cladding mchanical interaction and the stored fission gas pressure. The cladding is modeled as a thin-walled tube and the fuel is modeled as a ring with its inner radius determined by the inviscid temperature. The input procedures and the program logic permit the analysis of operation both in the steady state and during power and temperature changes. The analytical basis, the program capabilities, the program construction and the results of preliminary calibration of the code to experimental data are presented. 8 references. (auth)

3211 (HEDL-SA—985) **Effect of oxygen in sodium upon radionuclide release from austenitic stainless steel.** Brehm, W.F. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. 30p. (CONF-750972—2). Dep. NTIS $4.50.

From IAEA specialists meeting on fission and corrosion products in primary systems of LMFBR?s; Dimitrovgrad, USSR (8 Sep 1975).

A major purpose of the Radioactivity Control Technology program is to determine the effect of oxygen in sodium upon release of ^{54}Mn, ^{60}Co, and ^{58}Co from irradiated 316 stainless steel, and the distribution of the deposited nuclides in the test system. Determining the effect of oxygen in sodium upon nuclide release will define purification system equipment and operational requirements for FFTF/CRBR and future LMFBR's. A reduction in nuclide release is necessary to lower gamma dose rates in equipment cells during maintenance and repair operations, which in turn will decrease downtime and maximize plant use factor and reduce doubling time. The work was conducted in Source Term Control Loop No. 1 (STCL-1) with a specimen temperature of 604°C (1120°F), a loop minimum temperature of 427°C (800°F), sodium velocity at the specimens of 6.7 to 7.6 m/s (22 to 25 ft/sec) and oxygen levels of 0.5 +- 0.1 ppm and 2.5 +- 0.1 ppm. A reduction of greater than a factor of two in specimen weight loss was observed upon operation of the test system at 0.5 rather than 2.5 ppm oxygen. The corrosion of iron from the specimens was reduced by greater than a factor of five. The release of ^{54}Mn was reduced by about 30 percent at the lower oxygen level, while the release of $^{60}Co^{+}$ has an apparent reduction of greater than a factor of three, but with considerable scatter in the data. Reductions of this magnitude are insufficient to completely solve the nuclide release and deposition problem, but sufficient to recommend operation of LMFBR facilities at as low an oxygen level as possible (certainly less than 1 ppm and less than 0.5 ppm if possible). (auth)

3212 (HEDL-TME—75-3) **HEDL quarterly technical report, January, February, March 1975.** Atwood, J.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). May 1975. Contract AT(45-1)-2170. vp. AT.

Progress is reported in the following areas: sodium systems development, radioactive corrosion products, fuel failure monitoring, and development of sodium characterization systems. (JWR)

3213 (ANL-Trans—997) **Development of some study and construction techniques of a sodium cooled fast reactor.** Payan, G.; Milan, D.; Savornin, B. 1972. Translation of French report. (CONF-721062—11). 14p. Dep. NTIS $4.50.

From NUCLEX 1972) 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

The present stage of certain advanced mechanical studies which were undertaken during execution of Phenix core-vessels is described, together with their scope of development: strength of materials, with a due account of creep problems; flow-induced random vibrations; and electron-beam welding of large austenitic steel sheets. 6 references. (auth)

3214 (ANL-Trans—998) **Some aspects of the sodium pump for the future fast breeder reactor.** Raczynski, W.; Cazes, M.; Refoublelet, P. 1972. Translation of French report. (CONF-721062—12). 19p. Dep. NTIS $4.50.

From NUCLEX 1972) 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

The next stage of breeder reactor development will be the design and specification of a commercial power plant. As regards the components of this power plant, a change will be noted: in some cases, this change will result in a large increase in size as compared with present state. Ppoblems encountered during preliminary studies on sodium pumps are described. (auth)

3215 (ANL-Trans—999) **Problems raised by the design and manufacture of loading plugs for sodium cooled fast reactors.** Lagrange, M.; Chevallier, R.; Perona, M. 1972. Translation of French report. (CONF-721062—10). 15p. Dep. NTIS $4.50.

From NUCLEX 1972) 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

Designing and manufacturing a loading plug (or rotating shield plug) such as that of the Phenix Reactor present various problems relating to wide number of fields. After enumeration of the functions of the Phenix loading plug, the principal optiions taken during the design period are analysed. The loading plug is then described. The main features of manufacture of these parts, both in the shops and on the site are recalled. (auth)

3216 (ANL-Trans—988) **Hydrotechnical problems in the steam generator of the Phenix reactor.** Andro, M.; Salon, M. 1972. Translation of CONF-720648—10. 14p. Dep. NTIS $4.00.

A number of problems arose in the design of the Phenix reactor's steam generators, which were associated with the distribution and flow of sodium in the parallel-connected modules and the buffer tanks for the steam generator. Operating data obtained on the E.D.F. les Renardieres power plant sodium-heated vapor generator circuit confirmed the results of previous research and tests at the Grand Quevilly Thermal Research Centre and National Hydraulics Laboratory at Chatou. (auth)

3217 (ORNL-tr—4033) **High-temperature unstabilized austenitic steel X6CrNi1811 for sodium-cooled reactor vessels, submerged arc welding.** Wallner, F.; Herberg, G. 1974. Translated by E.G. Silver of German report. (CONF-741094—31). 38p. Dep. NTIS $5.00.

From International colloquium on welding in nuclear engineering; Duesseldorf, F.R. Germany (23 Oct 1974).

The high operating temperatures of fast sodium-cooled breeder reactors (FBR's) require the use of high-temperature resistant austenitic steels for the fabrication of the reactor tank and the reactor interior. Certain investigations on submerged arc welding which have made it possible to apply this method in practical situations are reviewed. (auth)

3218 Temperature noise measurements in blocked and unblocked 19-pin electrically heated LMFBR fuel subassembly mockups. Fry, D.N. (Oak Ridge National Lab., TN). *Ann. Nucl. Energy*; 2: 233-234(1975).

Sodium temperature noise was measured at the exit of a simulated fast reactor fuel subassembly to determine the feasibility of using temperature noise monitors to detect flow blockages in fast reactors, a matter of ever-increasing concern in the LMFBR program. Noise from both blocked and unblocked test bundles was characterized using various noise signal descriptors such as power spectral density, cross spectral density, amplitude probability distribution, and root mean square (rms). (auth)

3219 Dynamic heat transfer experiments in an electrically heated LMFBR fuel element mockup. Fry, D.N.; Kerlin, T.W.; Sides, W.H. (Oak Ridge National Lab., TN). *Ann. Nucl. Energy*; 2: 235-236(1975).

Experiments were performed at the Fuel Failure Mockup Facility to obtain data for use in determining heat transfer and flow paths in simulated LMFBR fuel bundles that were operated with and without flow blockages. The heat input to one rod of a 19-rod bundle was modulated, and the temperature responses were monitored with thermocouples at various positions in the bundle. The experimental data were processed to yield frequency responses for the measured thermocouple-heater pairs. The experimental results are discussed. (auth)

3220 (CONF-750411—41) **Fuel management codes for fast reactors.** Sicard, B.; Coulon, P.; Mougniot, J.C.; Gouriou, A.; Pontier, M.; Skok, J.; Carnoy, M.; Martin, J. (CEA, 75 - Paris (France)). 1975. Translation of a French report. 30p. Dep. NTIS $4.00.

From European nuclear conference; Paris, France (21 Apr 1975).

The CAPHE code is used for managing and following up fuel subassemblies in the Phenix fast neutron reactor; the principal experimental results obtained since this reactor was commissioned are analyzed with this code. They are mainly concerned with following up fuel subassembly powers and core reactivity variations observed up to the beginning of the fifth Phenix working cycle (3/75). Characteristics of Phenix irradiated fuel subassemblies calculated by the CAPHE code are detailed as at April 1, 1975 (burn-up steel damage). (auth)

3221 (CONF-750411—40) **System for incident detection and core surveillance for a fast reactor.** de Lapparent, D.; Gourdon, J.; Gouriou, A.; Jeannot, A.; Jallade, M.; Le Guillou, G.; Pages, J.P.; Paziaud, A.; Quinton, J.C.; Tigeot, Y. (CEA, 75 - Paris (France)). 1975. Translation of a French report. 26p. Dep. NTIS $4.00.

From European nuclear conference; Paris, France (21 Apr 1975).

The incident detection system of a Fast Reactor core covers three fields: (1) normal working (check on running order), (2) the incident situation (with alert and scram), and (3) the intermediate field in which the defect arises. The principal incidents threatening a core are reviewed, as are their new aspects when moving onto a large scale plant required to meet electric power mains. Lastly, the Surveillance and Protection System of the Super Phenix core is described. (auth)

3222 Electric utility view of the liquid metal fast breeder reactor. Behnke, W.B. (Commonwealth Edison Co., Chicago). pp 56-59 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A summary of the electric utility view of the LMFBR and the Clinch River Breeder Reactor project is presented. (JWR)

3223 Role and objectives of the Clinch River Breeder Reactor Plant. Van Nort, P.S. (Project Management Corp., Chicago). pp 60-61 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The objectives of the CRBRP project are discussed and the status of the project is reviewed. (JWR)

3224 Commercialization of the breeder. Richards, R.B.; Horst, K.M.; Gibson, A.S.; Palmer, R.S. (General Electric Co., Sunnyvale, CA). pp 62-69 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Topics discussed include: the economic and environmental incentives for the breeder; the time urgency for introduction of the breeder as a commercial energy source; and the development steps leading to commercialization of the breeder. (JWR)

3225 Development and testing requirements for major LMFBR components. Iacobellis, S.F. (Atomics International Div., Canoga Park, CA). pp 70-77 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A review is presented on the development status of major LMFBR components, the technical uncertainties in individual areas, and the capabilities of the major component testing facilities. (JWR)

3226 French LMFBR programs. pp 78-81 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The French LMFBR program is traced from the RAPSODIE experimental reactor through the PHENIX and SUPER PHENIX projects. (JWR)

3227 UF_6 breeder: a solution to the problems of nuclear power. Williams, J.R.; Clement, J.D.; Rust, J.A. (Georgia Inst. of Tech., Atlanta). pp 308-313 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Rapidly rising costs, adverse legislation, mounting public opposition and lack of a fuel reprocessing facility has resulted in over a hundred postponements and cancellations of power reactor orders during the past year and threatened the very existence of the nuclear industry. Serious consideration is now being given to a national moratorium because of the five fundamental problems of todays nuclear power reactors: cost, fuel reprocessing, safety, safeguards and radwaste. Careful consideration of viable fission-reactor alternatives which greatly reduce or eliminate these barriers to the public acceptance and widespread use of nuclear energy, is needed. Circulating-fuel breeder reactors with continuous fission-product removal and simplified on-site reprocessing have a potential for generating cheaper power and greatly reducing the safety and safeguards problems associated with fuel transportation. In addition, uranium hexafluoride gas fueled breeder reactors may "burn up" most, or possibly all, of their long-lived radioactive waste products. Because of the highly favorable economics, greatly simplified on-site fuel processing, enhanced safety (no fuel meltdown possible), and considerably reduced safeguards and radwaste problems, the uranium-hexafluoride breeder reactor may well be the solution to the problems facing the nuclear industry. Analytical studies for ^{233}U-F_6 fueled breeder reactors have predicted breeding ratios in the range of 1.2 to 1.3, fuel doubling times of a few years or less, and power plant efficiencies in the range of 35 percent to 50 percent. (auth)

3228 Conceptual design of a fluidized bed steam generator for the LMFBR. Keairns, D.L. (Westinghouse Research Labs., Pittsburgh); Newby, R.A.; Cooper, M.H.; Adkins, C.R.; Bieberbach, G. pp 338-341 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A fluidized bed steam generation system, FBSG, is being developed for the liquid metal fast breeder reactor, LMFBR. The FBSG eliminates the need for an intermediate sodium loop and heat exchanger utilized in the current design and isolates the sodium and water thus reducing the possibility of a sodium-water reaction. A conceptual design for a stacked sodium and water tube bundle fluidized bed steam generator is presented and the circulating fluidizing gas system is described. An experimental program is underway to develop design data and demonstrate concept feasibility. Results of initial tests are used to establish the conceptual design. The development program is discussed and objectives outlined. (auth)

3229 Comparison and evaluation of nuclear power plant options for geosynchronous power stations. Williams, J.R. (Georgia Inst. of Tech., Atlanta). pp 1264-1274 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A solution to the safety, safeguards, and radwaste disposal problems of nuclear power is to locate the breeder reactor power plants far out in geosynchronous orbit and beam the power to earth with microwaves. The generation of nuclear power in space is technologically feasible and has already been demonstrated on a small scale. It has also been shown that high efficiency microwave transmission of power from synchronous orbit to earth is feasible and is not hazardous. The reactor safety problem would be virtually eliminated because of the remoteness of the satellite power station in geosynchronous orbit. The worst possible accident at such a plant would have negligible effect on the earth, certainly less than the high altitude nuclear explosions which have been conducted in the past. Accidental re-entry from geosynchronous orbit could not occur because of the very large velocity change required. The safeguards problem can be virtually eliminated by adopting the following procedures: 1) The plant is initially started up using U-235 fuel or bred plutonium or U-233 from another geosynchronous power plant, 2) Once the plant is operating, only nonhazardous fertile materials (thorium or depleted uranium) are shipped up from earth, 3) The fissile fuel is bred and used in space, and none of this highly toxic fissile material is ever returned to earth. The radioactive waste could be concentrated and ejected in canisters into deep space away from the earth. The geosynchronous nuclear power plant offers unlimited nuclear power without nuclear hazards or nuclear pollution, but at somewhat higher cost. Whether or not society will be willing to pay these higher costs of nuclear power from space, or whether new energy resources such as nuclear fusion or solar power become feasible, remains to be seen. A prudent course to follow would be to give careful consideration to all future options for large scale energy generation, including the option of nuclear power from space. (auth)

3230 (ANL-Trans—1019) **Study of the upper shielding of the Phenix reactor: comparison between the methods S/sub N/ and Monte-Carlo.** Lanore, J.M. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France)). Jul 1975. Translated by J. Banfield from CEA-N—1351. 21p. Dep. NTIS $4.50.

The attenuation of the neutrons in the superior protection of Phenix is calculated for the solutions B_4C, dense graphite, and stainless steel with help of the Monte-Carlo POKER code. The results are compared to the preliminary calculations made with the SN NIOBE code. (auth)

REGULATION AND LICENSING

3231 (REG/G—1.107) **Qualifications for cement routing for prestressing tendons in containment structures.** (Nuclear Regulatory Commission, Washington, D.C. (USA). Office of Standards Development). Nov 1975. 6p. NUREG.

This guide describes quality standards acceptable to the NRC staff for the use of portland cement grout as the corrosion inhibitor for prestressing tendons in prestressed concrete containment structures. (auth)

3232 (RDT-P—2-5T(Rev.)(10-75)) **Medium voltage switchgear.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Reactor Research and Development). Oct 1975. 13p. RSO.

This standard establishes the requirements for the design, fabrication, testing and quality assurance for medium voltage switchgear up to 15 kV ratings for nuclear reactors. Compliance with ANSI C37 forms part of the requirements of this standard. Plant Protection System (PPS) undervoltage sensing devices are not covered by this standard. (auth)

PROCESS HEAT REACTORS

3233 Very high temperature reactor (VHTR) technology. Jones, A.R. (Westinghouse Astronuclear Lab., Pittsburgh). pp 329-337 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

A nuclear reactor with the capability of providing heat in helium at 1700 to 1850°F is attractive in a broad spectrum of high performance systems. Two variants of a very high temperature reactor (VHTR) concept, which have been explored in some detail, are described. The purpose of the Westinghouse Astronuclear Laboratory (WANL) design studies has been to evaluate feasibility and practicality and to provide characteristic data. In order to accomplish this, a reference application was selected for each of the two classes—mobile and process heat. The study applications selected were the 2000 ton SES for mobile and coal conversion to synthetic hydrocarbons for process heat. The effort to date has illustrated the feasibility of the VHTR concept, produced typical conceptual designs, identified sources of the basic technology needed for the remaining development effort, identified an R and D plan to produce the engineering data for demonstration units and produced cost estimates therefor. The commonality of the R and D effort is illustrated in that roughly three quarters of the total effort is applicable to both classes. Obviously, the demonstration units are separate and distinct although each demonstration program could make important contributions to the other class. (auth)

NUCLEAR REACTOR TECHNOLOGY

THEORY AND CALCULATION

3234 (CONF-751101—30) **Linear filtering applied to Monte Carlo criticality calculations.** Morrison, G.W.; Pike, D.H.; Petrie, L.M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A significant improvement in the acceleration of the convergence of the eigenvalue computed by Monte Carlo techniques has been developed by applying linear filtering theory to Monte Carlo calculations for multiplying systems. A Kalman filter was applied to a KENO Monte Carlo calculation of an experimental critical system consisting of eight interacting units of fissile material. A comparison of the filter estimate and the Monte Carlo realization was made. The Kalman filter converged in five iterations to 0.9977. After 95 iterations, the average k-eff from the Monte Carlo calculation was 0.9981. This demonstrates that the Kalman filter has the potential of reducing the calculational effort of multiplying systems. Other examples and results are discussed. (auth)

3235 (ORNL—4938) **KENO IV: an improved Monte Carlo criticality program.** Petrie, L.M.; Cross, N.F. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 213p. Dep. NTIS $7.60.

KENO IV is a multigroup Monte Carlo criticality program written for the IBM 360 computers. It executes rapidly and is flexibly dimensioned so the allowed size of a problem (i.e., the number of energy groups, number of geometry cards, etc., are arbitrary) is limited only by the total data storage required. The input data, with the exception of cross sections, fission spectra and albedos, may be entered in free form. The geometry input is quite simple to prepare and complicated three-dimensional systems can often be described with a minimum of effort. The results calculated by KENO IV include k-effective, lifetime and generation time, energy-dependent leakages and absorptions, energy- and region-dependent fluxes and region-dependent fission densities. Criticality searches can be made on unit dimensions or on the number of units in an array. A summary of the theory utilized by KENO IV, a section describing the logical program flow, a compilation of the error messages printed by the code and a comprehensive data guide for preparing input to the code are presented. 14 references. (auth)

3236 (ORNL—5062) **VENTURE: a code block for solving multigroup neutronics problems applying the finite-difference diffusion-theory approximation to neutron transport.** Vondy, D.R.; Fowler, T.B.; Cunningham, G.W. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. vp. Dep. NTIS $10.60.

The computer code block VENTURE, designed to solve multigroup neutronics problems with application of the finite-difference diffusion-theory approximation to neutron transport (or alternatively simple P_1) in up to three-dimensional geometry is described. A variety of types of problems may be solved: the usual eigenvalue problem, a direct criticality search on the buckling, on a reciprocal velocity absorber (prompt mode), or on nuclide concentrations, or an indirect criticality search on nuclide concentra-

tions, or on dimensions. First-order perturbation analysis capability is available at the macroscopic cross section level. (auth)

3237 (ORNL-TM—4758) **Development and application of a three-point inverse kinetics rod-drop technique for subcriticality determination.** Allen, J.W. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 90p. AT.

Thesis.

The subcritical reactivity of a reactor was determined by an Inverse Kinetics Rod-Drop (IKRD) method using a simple algorithm with error analyses involving statistical and parametrical uncertainties. The algorithm was developed to calculate reactivity, without using iteration procedures, from the observed neutron detector response using the point kinetics reactor model with a course. The algorithm can be incorporated into a computer on-line with a reactor to yield nearly instantaneous results. The algorithm included the following features (1) the statistical precision of the reactivity, (2) the sensitivity of reactivity to changes in the point kinetics parameters of effective delayed neutron group fractions and time constants, and (3) the uncertainty in reactivity due to uncertainties in the above parameters. An analysis of experimental problems was done including detector counting loss corrections, correction for detection efficiency changes and optimization of rod-drop dynamic range. The algorithm was successfully applied on both an on-line and off-line computer to count rate data from IKRD experiments with the engineering core mockup for the Fast Flux Test Facility reactor. The reactivity results agreed with those measured by other means and were obtained with statistical and parametrical uncertainties. The correction for detector counting loss and detection efficiency changes necessary for an accurate result in an on-line computer calculation were also successfully included in the algorithm for the IKRD experiments. (auth)

COMPONENTS AND ACCESSORIES

3238 (ANL-CT—76-9) **Vibrations of circular cylindrical shells.** Chung, H. (Argonne National Lab., Ill. (USA)). Jul 1975. Contract W-31-109-Eng-38. 51p. Dep. NTIS $5.50.

An exact solution method for the free vibration problem of thin circular cylindrical shells is presented. The differential equations of motion are solved directly with the use of simple Fourier series as the modal displacement functions. Stokes' transformation is exploited to obtain correct series expressions for the derivatives of the Fourier series. From this method an explicit expression of the exact frequency equation can be obtained for any kind of boundary conditions. The accuracy of the present method is checked against available data. The proposed method is then used to find the modal characteristics of the thermal liner of the Fast Test Reactor (FTR). The numerical results obtained are compared with finite element method solutions. (auth)

3239 (CONF-751036—1) **Two-phase flow velocity measurement using radiation intensity correlation.** Lassahn, G.D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 7p. Dep. NTIS $4.50.

From International standards association conference; Milwaukee, Wisconsin, USA (6 Oct 1975).

Flow velocities of two-phase fluids can be measured by transit time techniques using radiation beams as sensors to detect the passing of inhomogeneities. A Fourier spectrum analysis can be used as a kind of correlation or averaging technique to extract the velocity information from the signal-noise mixture. (auth)

3240 (ORNL-RSIC—39) **Development of radiation shielding standards in the American Nuclear Society.** Trubey, D.K. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 11p. Dep. NTIS $4.00.

The American Nuclear Society (ANS) is a standards-writing organization-member of the American National Standards Institute (ANSI). The ANS Standards Committee has a subcommittee denoted ANS-6, Shielding, whose charge is to establish standards in connection with radiation protection and shielding, to provide shielding information to other standards writing groups, and to prepare recommended sets of shielding data and test problems. This paper is a progress report of this subcommittee. (auth)

3241 (SAND—75-5684) **Application of elasticity theory at Sandia Labortories.** Davison, L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-750932—1). Dep. NTIS $4.00.

From Annual meeting of the Society of Engineering Science; Austin, Texas, USA (21 Sep 1975).

Examples are given of the application of linear elasticity theory to the solution of practical problems encountered at Sandia Laboratories. It is being applied to a very broad range of problems: those in one, two, and three spatial dimensions, some involving static and some dynamic response, to materials having isotropic and anisotropic symmetry, to homogeneous and inhomogeneous bodies, etc. Various extensions of the theory to include electric, magnetic and thermal effects, to account for material microstructure, for radiation and spall damage, chemical reactions, and other phenomena have been developed and/or applied. In some applications linear elasticity represents the physics of a problem well and is the theory of choice. In others the theory was used because it lent insight into a larger problem that was also attacked by means of other theories and/or experiment, and in some cases it serves as a part of a more encompassing theory. (auth)

3242 (ERDA-tr—52) **Standards for calculating strength of reactor components, steam generators, vessels, and piping of atomic power stations, test and research reactors, and installations.** Oct 1975. Translation of Normy rascheta na prochnost' elementov reaktorov, parogeneratorov, sosudov i truboprovodov atomnykh elektrostantsii, opytnykh i issledovatel'skikh yadernykh reaktorov i ustanovok, Moscow, 1973. 308p. Dep. NTIS $7.60.

Information is presented which was compiled on the basis of Soviet and foreign theoretical and experimental investigations of the strength of the elements of atomic reactor vessels, steam generators, piping, fuel channels and other equipment with regard to the accumulated experience in design, manufacture, and operation. The recommended methods of calculating the stresses and displacements in the structural members and methods of determining the mechanical properties of the materials are presented in the appendices. The standards are compulsory for all agencies, design organizations, and enterprises which design, manufacture, and operate atomic power stations and nuclear reactors controlled by Gosgortekhnadzor of the USSR [state committee of the council of ministers for supervision of industrial safety and for mining inspection]. They may be useful to workers of all organizations engaged in manufacture and operation of pressure vessels. (auth)

FUEL ELEMENTS

3243 (CONF-751016—3) **Acoustic emission from thermal-gradient cracks in UO_2.** Kennedy, C.R.; Kupperman, D.S.; Wrona, B.J. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 23p. Dep. NTIS $4.50.

From Conference of the American Society for Nondestructive Testing, Inc.; Atlanta, Georgia, USA (13 Oct 1975).

A feasibility study has been conducted to evaluate the potential use of acoustic emission to monitor thermal-shock damage in direct electrical heating of UO_2 pellets. In the apparatus used for the present tests, two acoustic-emission sensors were placed on extensions of the upper and lower electrical feedthroughs. Commercially available equipment was used to accumulate acoustic-emission data. The accumulation of events displayed on a cathode-ray-tube screen indicates the total number of acoustic-emission events at a particular location within the pellet stack. These tests have indicated that acoustic emission can be used to monitor thermal-shock damage in UO_2 pellets subjected to direct-electrical heating. 8 references. (auth)

3244 (CONF-751113—7) **Experimental design for HTGR fuel rods.** Bayne, C.K. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 12p. Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

Fuel rods for the high temperature gas cooled reactor are composed of pyrolytic carbon coated fuel particles bounded by a carbonaceous matrix. Because of differential shrinkage between coated particles and the carbonaceous matrix, breakage of the pyrolytic coating has been observed with certain combinations of coated particles and matrix compositions. The pyrolytic coating is intended to be the primary containment for fission products. Therefore, an experiment is desired to determine the breakage characteristics of different strength coated particles combined with different matrix compositions during irradiation. (auth)

CONTROL SYSTEMS

3245 (CONF-750303—78) **Integral capture cross-section measurements in the CFRMF for LMFBR control materials.** Anderl, R.A.; Harker, Y.D.; Turk, E.H.; Nisle, R.G.; Berreth, J.R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 4p. Dep. NTIS $4.50.

From Proceedings on nuclear cross section and technique; Washington, District of Columbia, USA (3 Mar 1975).

Integral capture-cross sections for separated isotopes of Eu and Ta are reported for measurements in the Coupled Fast Reactivity Measurements Facility (CFRMF). These cross sections along with that measured in the CFRMF for $^{10}B(n,\alpha)$ provide an absolute standard for evaluating the relative reactivity worth of Eu_2O_3, B_4C and Ta in neutron fields typical of an LMFBR core. Based on these measurements and for neutron fields characterized by the ^{235}U:^{238}U reaction rate spectral index ranging from 23 to 50, the infinitely dilute relative worth of Eu_2O_3 has been estimated to be 25 to 40 percent higher than that for B_4C and 80 percent to 100 percent higher than that for Ta. 11 references. (auth)

ENVIRONMENTAL ASPECTS

3246 (ANL-Trans—1000) **Fast neutron reactor power plant Phenix.** Megy, J.; Guillemard, B.; Robert, E.; Crette, J.P.; Labat, P. 1972. Translation of French report. (CONF-721062—9). 16p. Dep. NTIS $4.50.

From NUCLEX 1972) 3rd international fair of nuclear industries and technical meetings; Basel, Switzerland (16 Oct 1972).

Main features of Phenix, i.e., power integrated design, fuel and fuel handling cycles are summarized. The main difficulties met and solutions which were selected in the field of design, main component tests and manufacturing are described. (auth)

SITING

3247 (UCRL—77371) **Site response calculations for nuclear power plants.** Wight, L.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Oct 1975. Contract W-7405-Eng-48. 24p. (CONF-751204—1). Dep. NTIS $4.25.

From ASCE specialty conference; New Orleans, Louisiana, USA (8 Dec 1975).

Six typical sites consisting of three soil profiles with average shear wave velocities of 800, 1800, and 5000 ft/sec as well as two soil depths of 200 and 400 ft were considered. Seismic input to these sites was a synthetic accelerogram applied at the surface and corresponding to a statistically representative response spectrum. The response of each of these six sites to this input was calculated with the SHAKE program. The results of these calculations are presented. (auth)

RESEARCH, TEST, EXPERIMENTAL, ZERO-POWER, AND TRAINING REACTORS AND SUBCRITICAL ASSEMBLIES

3248 (CONF-750431—3) **Variable reluctance displacement transducer temperature compensated to 650°F.** (Aerojet-General Corp., Sacramento, Calif. (USA)). 1975. 13p. Dep. NTIS $4.50.

From 8. transducer workshop; Dayton, Ohio, USA (21 Apr 1975).

In pressurized water reactor tests, compact instruments for accurate measurement of small displacements in a 650°F environment are often required. In the case of blowdown tests such as the Loss of Fluid Test (LOFT) or Semiscale computer code development tests, not only is the initial environment water at 650°F and 2200 psi but it undergoes a severe transient due to depressurization. Since the LOFT and Semiscale tests are run just for the purpose of obtaining data during the depressurization, instruments used to obtain the data must not give false outputs induced by the change in environment. A LOFT rho v^2 probe and a Semiscale drag disk are described. Each utilizes a variable reluctance transducer (VRT) for indication of the drag-disk location and a torsion bar for drag-disk restoring force. The VRT, in addition to being thermally gain and null offset stable, is fabricated from materials known to be resistant to large nuclear radiation levels and has successfully passed a fast neutron radiation test of 2.7×10^{17} nvt without failure. (auth)

3249 (CONF-750469—1) **Component design for LMFBR's.** Fillnow, R.H.; France, L.L.; Zerinvary, M.C.; Fox, R.O. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). 1975. 17p. Dep. NTIS $4.00.

From Annual American power conference; Chicago, Illinois, USA (21 Apr 1975).

Just as FFTF has prototype components to confirm their design, FFTF is serving as a prototype for the design of the commercial LMFBR's. Design and manufacture of critical components for the FFTF system have been accomplished primarily using vendors with little or no previous experience in supplying components for high temperature sodium systems. The exposure of these suppliers, and through them a multitude of subcontractors, to the requirements of this program has been a necessary and significant step in preparing American industry for the task of supplying the large mechanical components required for commercial LMFBR's. (auth)

3250 (CONF-750607—34) **Fabrication of internally instrumented reactor fuel rods.** Schmutz, J.D.; Meservey, R.H. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 10p. Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

Procedures are outlined for fabricating internally instrumented reactor fuel rods while maintaining the original quality assurance level of the rods. Instrumented fuel rods described contain fuel centerline thermocouples, ultrasonic thermometers, and pressure tubes for internal rod gas pressure measurements. Descriptions of the thermocouples and ultrasonic thermometers are also contained. (auth)

3251 (CONF-750698—1) **Inelastic analysis of EBR II: IHX secondary outlet nozzle.** Ahmed, H.; Stone, C. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 29p. Dep. NTIS $4.50.

From United States;Japanese specialists meeting; Washington, District of Columbia, USA (19 Jun 1975).

Thermal stress analysis for the EBR-2 reactor intermediate heat exchanger is presented. The sodium inlet and outlet temperatures are determined from a reactor thermal analysis. The effects of thermal transients on the structural integrity of the heat exchanger are evaluated. Inelastic strain evaluation and creep-fatigue evaluation are described. 14 references. (DCC)

3252 (CONF-750935—3) **Fast neutron spectrum and dosimetry studies in the Coupled Fast Reactivity Measurements Facility.** Rogers, J.W.; Harker, Y.D.; Millsap, D.A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 20p. Dep. NTIS $4.50.

From 1. ASTM-Euratom symposium on reactor dosimetry(developments and standarization; Petten, Netherlands (22 Sep 1975).

The fast neutron spectrum of the Coupled Fast Reactivity Measurements Facility (CFRMF) at the Idaho National Engineering Laboratory (INEL) is being used to study and standardize fast reactor neutron dosimetry materials and methods. The CFRMF has been designated a "benchmark experiment" to test the cross section data of dosimetry materials as well as other materials used and produced in fast reactors. Information about the neutron energy spectrum of the CFRMF is presented. (auth)

3253 (CONF-750966—3) **LMFBR safety testing needs and the conceptual design of a new safety research experiment facility.** Marchaterre, J.F.; Matlock, R.G.; Goldman, A.J. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 20p. Dep. NTIS $4.00.

From International conference on extreme load conditions and limit analysis procedures for structural reactor safeguards and containment structures; West Berlin, F.R. Germany (8 Sep 1975).

Experiment needs for the LMFBR safety program are reviewed. The screening of reactor concepts which would meet the needs is described and a conceptual design for a new safety research experiment facility is presented. (JWR)

3254 (CONF-751012—10) **Brazed thermocouple pass-through for sodium service in a liquid-metal-cooled fast breeder reactor.** Walker, D.E. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 14p. Dep. NTIS $4.50.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

Sensors installed in special fuel elements for the EBR-II reactor had 30-ft-long leads that would pass from the sodium environment through a sealed bulkhead. A hydrogen-atmosphere, induction-heated brazing furnace was constructed to simultaneously braze 20-26 separate sensor leads at one time. The brazed seals were leak-tight, and the sheath wall has less than 10 percent interaction with the braze alloy. (auth)

3255 (CONF-751101—18) **Power Burst Facility: power oscillation problem.** Lussie, W.G.; Wadkins, R.P.; Wells, R.A. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 7p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

In late 1973 PBF achieved a power level of 15 MW. During this period of operation fluctuations in reactor power were observed. Many possible causes of these fluctuations were considered and a number of nuclear and non-nuclear tests were conducted.

Initial instrumentation installed in the core showed coolant outlet temperature variations of 10°F for several fuel cannisters and approximately 10 percent power variations at 15 MW. Power spectral density analysis showed a predominant frequency of 0.05 to 0.06 HZ. The testing program to determine the cause of the power oscillations is described. (auth)

3256 (CONF-751101—31) **Subcriticality calculations for the FFTF reverse approach to critical experiment.** Selby, D.L.; Flanagan, G.F. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 5p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The reverse approach to critical (RAC) experiments were performed in the ZPR-IX critical facility at Argonne National Laboratory. One of the major objectives of this project is to determine the adequacy of the low-level flux monitor (LLFM) detectors for initial loading of the Fast Flux Test Facility (FFTF). 5 references. (auth)

3257 (HEDL-SA—979) **Full scale withdrawal testing of FFTF/LMFBR fuel assemblies.** Richman, R.B.; Fiskum, O.S.; LeGore, T. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1975. Contract E(45-1)-2170. (CONF-751101—46). Dep. NTIS $5.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Withdrawal characteristics of five major designs of fuel assembly nozzle were evaluated. Results of these tests contributed to development of the final FTR core design, comprising a nozzle with a single upper piston ring and a lower close-clearance region in an Inconel 718 receptacle liner. Testing in both the sodium environment and in air verified the choice of a chromium-plated fuel assembly nozzle to provide superior resistance to nozzle wear, and to preclude any damage to the long-life liner. (auth)

3258 (HEDL-TME—75-97) **FTR HCM scale-model shaker test.** Ryan, J.A.; Simmons, M.D.; White, R.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. 44p. AT.

Characteristic response frequencies, mode shapes and damping values were experimentally determined on head-hung components in the Hydraulic Core Mockup (HCM), a quarter scale FTR model. Tests were performed in-situ, with and without water in the vessel. Test results have been used to determine the virtual mass effects of the water/structure interface, to evaluate HCM modelling accuracy, and to assist in the interpretation of flow-induced vibration data. (auth)

3259 (LMEC—75-11) **FFTF pump seal test final report.** Hall, J. (Liquid Metal Engineering Center, Canoga Park, Calif. (USA)). 15 Sep 1975. Contract E(04-3)-700. 210p. AT.

A series of checkout and performance tests of the FFTF prototype pump seals was conducted at the LMEC to determine the suitability of candidate seal designs for application to the FFTF pump. The test program included pre-test inspections, checkout testing, performance testing, and post-test inspections and measurement of seal wear. Life testing of the seals was originally planned but was later deleted from the program. Seal testing included performance at two levels of pressure: primary pump conditions at 10 psig nominal, and secondary pump conditions at 160 psig nominal pressure. The test program confirmed that the basic seal design was satisfactory. Testing of an alternate design was included, although testing of the prototype design occupied most of the program. Results obtained in this test program revealed the need for certain modifications to the prototype pump. Most of these were incorporated in the final configuration of the pump. A significant result of checkout testing revealed the need for hydrostatic lift-off capability in the Kingsbury thrust bearing. (auth)

3260 (ORNL-TM—4939) **Temperature distribution in a 19-rod simulated LMFBR fuel assembly in a scalloped duct (Fuel Failure Mockup Bundle 1B)-record of experimental data.** Fontana, M.H.; Gnadt, P.A.; Kress, T.S.; MacPherson, R.E.; Parsly, L.F.; Wantland, J.L. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 178p. AT.

Experimental data obtained from Fuel Failure Mockup bundle 1B, which simulated the configuration and power level of a segment of a Fast Test Reactor fuel subassembly, is presented. Bundle 1B consisted of 19 electric cartridge heaters with outside diameters of 0.230 in. spaced by 0.056-in. wire wraps on a 12-in. pitch and enclosed in a scalloped duct. The purpose of this test series was to obtain thermal-hydraulic data for use in design of the Fast Test Reactor core. The report includes a description of the system and the experimental procedures, a discussion of the data reduction procedures, and tabulated data from the experiments performed in this series. (auth)

3261 (ORNL-TM—4996) **Description of FTR design-oriented irradiation test of Eu_2O_3 in EBR-II.** Martin, M.M.; Pasto, A.E.; Woods, J.W.; Donnelly, R.G. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 64p. AT.

The experiment described in this document is designed to investigate the performance of cubic and monoclinic europia in a fast-reactor environment. As an advanced absorber material, Eu_2O_3 offers the possibility of a reliable, long-lived, environmentally acceptable, and economical control system. A distinct advantage is the absence of both helium and tritium generation in reactor. The general objective of this test is to qualify the irradiation behavior of Eu_2O_3 to reduce design uncertainties and permit its serious consideration for use in fast reactors. The description covers in detail the experimental objectives, design, thermal analysis, fabrication, characterization of test specimens and flux monitors, irradiation testing, and postirradiation examination plans. The experiment involves 223 Eu_2O_3 pellets in 23 pins inside 11 capsules. Irradiation will be conducted in three subassemblies designated by the EBR-II Project as X205, X205A, and X245. (auth)

3262 (ORNL-TM—5007) **Oak Ridge research reactor quarterly report January, February, and March of 1975.** Hurt, S.S. III; Lance, E.D. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 43p. Dep. NTIS $4.00.

The ORR operated at an average power level of 29.7 MW for 84.9 percent of the time during January, February, and March of 1975. Thirty-three fuel elements were declared spent (52.6 percent average burnup) during the quarter, while sixteen new elements were placed in service. Four shim rod elements were retired from service at an average burnup of 64.6 percent. The reactor was shut down on eleven occasions, two of which were unscheduled. Two end-of-cycle shutdowns accounted for 89.5 percent of the total downtime. The remaining downtime was used principally for refueling and experiment work. Maintenance activities, both mechanical and instrument, were essentially routine in nature. Special tests or measurements completed during the quarter included: (1) reactivity measurement with fuel removed from core position E5, (2) reactivity measurement with an Al core piece containing MoO_3 capsules in core position E5, (3) partial flux mapping of core, (4) shim rod calibrations, and (5) visual inspection of poolside facility. (auth)

3263 **Fluidelastic tube vibration in a heat exchanger designed for sodium -to-air operation.** Halle, H.; Boers, B.L.; Wambsganss, M.W. (Argonne National Lab., Argonne, Il.). *J. Eng. Power;* **97**: No. 4, 561-568(Oct 1975).

Analysis and testing were performed to evaluate the potential for flow induced vibrations of the finned U-tubes of a sodium-to-air dump heat exchanger of the Fast Flux Test Facility (FFTF). The analysis showed that fluidelastic vibration of the U-bend sections, caused by a displacement-dependent mechanism, could be experienced. Consequently, model tests, with prototypic tubing and stagnant water simulating the sodium mass on the tubeside, were performed. The tests consisted of subjecting the overhanging U-bends of a bank of five U-tubes to a range of air flow velocities at room temperature. Test results showed that, for a given support and restraint condition, a critical flow velocity exists above which large vibration amplitudes are induced. Characterization of the critical flow velocity was investigated. Supplementary single tube experiments determined vortex shedding frequencies, U-tube natural frequencies, damping, and, separately, the effect of internal water flow. (auth)

PLUTONIUM AND ISOTOPE PRODUCTION, CHEMONUCLEAR, MATERIALS TESTING, AND MATERIALS PROCESSING REACTORS

3264 (ORNL-TM—5025) **Seal modification for a V-band.** Abbatiello, A.A. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

An aluminum gasket with a small volume added at one point has been developed and is recommended for sealing a leak in the HFIR HB-1 beam-tube flange. This type of gasket, in a symmetrical form, was originally tested and proposed in February, 1972. It has now been revised to fit a specific eroded area (found when the HFIR was disassembled for a scheduled major overhaul, after ten years of operation. The modified gasket consists of a ring made of 0.093-in.-diam wire with the normal contour increased to $^1/_8$ in.^{2} in the section at the cavity region and oriented to place this section over the eroded area. Special tools and viewers are available for checking its position. (auth)

3265 (UNI—436) **Isotopic composition of irradiated Mark IV and Mark IA fuel.** McNeece, J.P. (United Nuclear Industries, Inc., Richland, Wash. (USA)). 29 Sep 1975. Contract AT(45-1)-1857. 60p. Dep. NTIS $5.50.

Fission product inventories were calculated with the computer code RIBD. Input physics and engineering parameters for RIBD and fissionable nuclide inventories were calculated with DCODE. Isotopic composition for both Mark IA and Mark IV fuel was calculated for exposures from 500 MWD/T to 5000 MWD/T in increments of 500 MWD/T and for cooling times out to 10 years. 10 references. (auth)

PROPULSION REACTORS

3266 (LAMS—2648) **Interaction of liquid hydrogen with the KIWI-B reactor.** Stiles, C.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 19 Jan 1962. Contract W-7405-Eng-36. 61p. Dep. NTIS $5.50.

Declassified 28 Aug 1973.

To obtain a better understanding of the interactions of core parameters when transient variations of hydrogen reactivity are introduced into the reactor, analog computer studies were made of the core dynamics using a model of the Kiwi-B reactor. Ten sets of data are presented and discussed in a qualitative fashion. The variation in the core parameters of most interest are presented for the following examples: varying the hydrogen flow rate while holding the control rods fixed, varying reactor power while holding the hydrogen flow rate constant and simultaneous variations in both reactor power and hydrogen flow rate. The trends and variaions in hydrogen flow rate, reactor power, outlet gas temperature, control rod activity, hydrogen reactivity and core temperature reactivity are discussed for each of the three conditions outlined. (auth)

3267 **Lightweight nuclear powerplant applications of a very high temperature reactor (VHTR).** Thompson, R.E. (Westinghouse Electric Corp., Pittsburgh). pp 1089-1097 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

Feasibility studies on the use of very high temperature reactors for propulsion applications are summarized. The applications include ships, air cushion vehicles, hydrofoils, and surface effect ships. The reactor design is based to a great deal on NERVA technology. (JWR)

REACTOR SAFETY

3268 (ANCR—1233) **Experiment data report for semiscale Mod-1 test S-02-3 (blowdown heat transfer test).** Crapo, H.S.; Jensen, M.F.; Sackett, K.E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Sep 1975. Contract E(10-1)-1375. 93p. Dep. NTIS $5.45.

Recorded test data are presented for Test S-02-3 of the Semiscale Mod-1 blowdown heat transfer test series. Test S-02-3 was conducted from an initial cold leg fluid temperature of 544°F and an initial pressure of 2,263 psig. A simulated double-ended offset shear cold leg break was used to investigate the system response to a depressurization transient with a moderately heated core (75 percent design power level). An electrically heated core was used in the pressure vessel to simulate the effects of a nuclear core. System flow was also set at the 75 percent design level to achieve full core temperature differential. The flow resistance of the intact loop was based on core area scaling. During system depressurization, core power was reduced from the initial level of 1.2 MW in such a manner as to simulate the surface heat flux response of the LOFT nuclear fuel rods until such time that departure from nucleate boiling (DNB) occurs. Blowdown to the pressure suppression system was accomplished without simulated emergency core coolant injection or pressure suppression system coolant spray. (auth)

3269 (ANCR—1240) **Intact loop pump performance during the Semiscale Mod-1 isothermal test series.** Loomis, G.G. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Oct 1975. Contract E(10-1)-1375. 50p. Dep. NTIS $5.45.

An analysis was performed on the Semiscale Mod-1 intact loop pump data taken during the Semiscale Mod-1 isothermal test series. The pump was shown to directly affect intact loop and vessel flow rates during the early portion of the simulated loss-of-coolant accidents (LOCAs). Comparison of pump performance data taken during the Semiscale Mod-1 isothermal tests with data obtained during previous steady state and transient tests indicated that the pump head degraded more rapidly during the Semiscale Mod-1 tests. Calculations using the pump model contained in the RELAP4 computer program are compared with these pump performance data. Areas of operation for the Semiscale Mod-1 pump are defined for the transient two-phase steam-water flows that occurred during several isothermal blowdown tests, and suggested refinement in the two-phase characteristics of the Semiscale Mod-1 pump model is offered. 13 references. (auth)

3270 (ANCR—1253) **Experiment data report for semiscale Mod-1 test S-01-6.** Crapo, H.S.; Jensen, M.F.; Sackett, K.E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). Sep 1975. Contract E(10-1)-1375. 92p. Dep. NTIS $5.45.

Recorded test data are presented for Test S-01-6 of the Semiscale Mod-1 isothermal blowdown test series. Test S-01-6 is one of several Semiscale Mod-1 experiments which are counterparts of the LOFT nonnuclear experiments. System hardware is representative of the LOFT design with the design based on volumetric scaling methods and with initial conditions duplicating those identified for LOFT nonnuclear tests. Test S-01-6 was conducted with an inactive 40-rod core in place of the orificed core simulator used on previous isothermal tests. The test was initiated at isothermal conditions of 2,263 psia and 541°F by a simulated offset shear of the cold leg broken loop piping. During system depressurization, coolant was injected into the cold leg of the operating loop to simulate emergency core cooling (ECC). (auth)

3271 (ANL—75-57) **Summary and evaluation: fuel dynamics loss-of-flow experiments (tests L2, L3, and L4).** Barts, E.W.; Deitrich, L.W.; Eberhart, J.G.; Fischer, A.K.; Meek, C.C. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 76p. Dep. NTIS $5.45.

Three similar experiments conducted to support the analyses of hypothetical LMFBR unprotected-loss-of-flow accidents are summarized and evaluated. The tests, designated L2, L3, and L4, provided experimental data against which accident-analysis codes could be compared, so as to guide further analysis and modeling of the initiating phases of the hypothetical accident. The tests were conducted using seven-pin bundles of mixed-oxide fuel pins in Mark-II flowing-sodium loops in the TREAT reactor. Test L2 used fresh fuel. Tests L3 and L4 used irradiated fuel pins having, respectively, "intermediate-power" (no central void) and "high-power" (fully developed central void) microstructure. 12 references. (auth)

3272 (ANL—75-58) **Light-water-reactor safety research program: quarterly progress report for April—June 1975.** Sachs, R.G. (Argonne National Lab., Ill. (USA)). 26 Sep 1965. Contract W-31-109-Eng-38. 83p. Dep. NTIS $5.45.

The Argonne National Laboratory work performed during April, May, and June 1975 on water-reactor-safety heat-transfer and flow problems is reported. The following research and development areas are covered: (1) Loss-of-coolant Accident Research; Heat Transfer and Fluid Dynamics; (2) Transient Fuel Response and Fission-product Release Program; and (3) Mechanical Properties of Zircaloy Containing Oxygen. (auth)

3273 (ANL—75-61) **REXCO predictions of elastic and elastoplastic deformation of fluid-filled pipes and comparisons with experiments of 1/10 scale FFTF pipe models.** Nagumo, G.; Fiala, C. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 44p. AT.

The reactor-containment code REXCO provides a two-dimensional capability to treat the plastic deformation of a pipe and to predict the effect of structural yield on the transmitted pressure pulse. The code is used to simulate two experiments of 1/10-scale pipe models of the FFTF primary loop where high-pressure pulses cause elastic and elastoplastic deformations of the pipe wall. Calculational and experimental results are compared to evaluate the experiments and to provide an interpretation of the data that is consistent with two-dimensional analysis. The results demonstrate the capability of the code to compute the elastic and elastoplastic deformations of pipes and to predict the hydrodynamic effect of wall deformation on the transmitted pressure pulse. The application of the code to scaled models is significant since the mathematical model of the pipe neglects the effect of strain rate and assumes a scaling factor of unity. 12 referenees. (auth)

3274 (ANL/RAS—75-42) **Contribution to the theory of the two phase blowdown phenomenon.** Hutcherson, M.N. (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-Eng-38. 359p. Dep. NTIS $11.50.

Thesis. Submitted to Univ. of Missouri, Columbia.

In order to accurately model the two phase portion of a pressure vessel blowdown, it becomes necessary to understand the bubble growth mechanism within the vessel during the early period of the decompression, the two phase flow behavior within the vessel, and the applicability of the available two phase critical flow models to the blowdown transient. To aid in providing answers to such questions, a small scale, separate effects, isothermal blowdown experiment has been conducted in a small pressure vessel. The tests simulated a full open, double ended, guillotine break in a large diameter, short exhaust duct from the vessel. The vaporization process at the initiation of the decompression is apparently that of thermally dominated bubble growth originating from the surface cavities inside the system. Thermodynamic equilibrium of the remaining fluid within the vessel existed in the latter portion of the decompression. A nonuniform distribution of fluid quality within the vessel was also detected in this experiment. By comparison of the experimental results from this and other similar transient, two phase critical flow studies with steady state, small duct, two phase critical flow data, it is shown that transient, two phase critical flow in large ducts appears to be similar to steady state, two phase critical flow in small ducts. Analytical models have been developed to predict the blowdown characteristics of a system during subcooled decompression, the bubble growth regime of blowdown, and also in the nearly dispersed period of depressurization. This analysis indicates that the system pressure history early in the blowdown is dependent on the internal vessel surface area, the internal vessel volume, and also on the exhaust flow area from the system. This analysis also illustrates that the later period of decompression can be predicted based on thermodynamic equilibrium. (auth)

3275 (BMI-X—664) **Sensitivity analyses for postulated LMFBR accident conditions.** Gieseke, J.A.; Reed, L.D. (Battelle Columbus Labs., Ohio (USA)). Oct 1975. Contract W-7405-eng-92. 70p. Dep. NTIS $5.45.

Predictions of released radioactivity resulting from postulated accidents in LMFBRs require that analyses of aerosol behavior be made. It is expected that many radiologically important species will be in the form of aerosol particles or adsorbed onto such particles. Materials anticipated to form aerosols are sodium oxide and fuel materials. The agglomeration growth, transport, deposition, and release from the containment of aerosols are predicted by the several available aerosol behavior models. The time-dependent size, concentration, deposition, and release of airborne particles are functions of assumed containment geometry and assumed initial aerosol properties. The computer-predicted effects of such assumed conditions on airborne aerosol mass concentration or mass leaked are discussed. Also, the effects of using different available computer codes are illustrated in terms of the details assumed for aerosol behavior mechanisms. The effects of assumed initial aerosol properties and of containment geometry serve to illustrate the importance of the various parameters thereby guiding the selection of critical experimental studies and the consideration of important containment design features. (auth)

3276 (CENPD—56) **Steam-water mixing test program. Task D: informal report. System design description for tasks A and B.** Lowe, P.A. (Combustion Engineering, Inc., Windsor, Conn. (USA). Nuclear Power Dept.). Jul 1972. Contract AT(11-1)-2244. 44p. Dep. NTIS $5.00.

The test apparatus for use in the Steam-Water Mixing Test Program is described. The apparatus is to be used for investigating the interaction of emergency core cooling water with steam flow generated by the core reflood. For physical scaling purposes, a typical four-inlet loop pressurized water reactor is modeled. The program background is outlined and the objectives are presented. The design basis and the measurement systems are discussed in detail. (auth)

3277 (CONF-750360—1) **Analysis of fuel behavior during reactivity initiated accidents.** Thompson, L.B.; Tolman, E.L.; MacDonald, P.E. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Mar 1975. Contract AT(10-1)-1375. 23p. Dep. NTIS $4..50.

From OECD halden reactor project conference; Geilo, Norway (17 Mar 1975).

An analysis of fuel rod behavior during reactivity initiated accidents is presented. The calculational approach is described, predictions are discussed and compared to data from the SPERT power excursion tests, and the sensitivity of maximum cladding temperatures to initial reactor conditions, enthalpy insertions, and other experiment design parameters is investigated. 10 references. (auth)

3278 (CONF-750607—35) **Thermal-hydraulic analysis of the first semiscale Mod-1 test series.** Mecham, D.C.; Cartmill, C.E. (Aerojet-General Corp., Sacramento, Calif. (USA)). 1975. 17p. Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

The predicted behavior of the semiscale Mod-1 system obtained through use of the RELAP4 computer program is compared with the experimentally observed response. Isothermal Test S-01-4A, chosen here as representative of the first test series, included a cold leg break configuration. The first test series was conducted under isothermal conditions. The electrically heated rods were replaced with a core simulator. (auth)

3279 (CONF-751101—15) **Lumped-parameter fuel rod model for rapid thermal transients.** Perkins, K.R.; Ramshaw, J.D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Jul 1975. Contract AT(10-1)-1375. 7p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The thermal behavior of fuel rods during simulated accident conditions is extremely sensitive to the heat transfer coefficient which is, in turn, very sensitive to the cladding surface temperature and the fluid conditions. The development of a semianalytical, lumped-parameter fuel rod model which is intended to provide accurate calculations, in a minimum amount of computer time, of the thermal response of fuel rods during a simulated loss-of-coolant accident is described. The results show good agreement with calculations from a comprehensive fuel-rod code (FRAP-T) currently in use at Aerojet Nuclear Company. (auth)

3280 (COO—2571-2) **Improvement and verification of fast reactor safety analysis techniques.** Jackson, J.F. (Brigham Young Univ., Provo, Utah (USA)). 1975. Contract AT(11-1)-2571. 21p. Dep. NTIS $4.50.

An initial analysis of the KIWI-TNT experiment using the VENUS-II disassembly code has been completed. The calculated fission energy release agreed with the experimental value to within about 3 percent. An initial model for analyzing the SNAPTRAN-2 core disassembly experiment was also developed along with an appropriate equation-of-state. The first phase of the VENUS-II/PAD comparison study was completed through the issuing of a preliminary report describing the results. A new technique to calculate a P-V-work curve as a function of the degree of core expansion following a disassembly excursion has been developed. The technique provides results that are consistent with the ANL oxide-fuel equation-of-state in VENUS-II. Evaluation and check-out of this new model are currently in progress. (auth)

3281 (GEAP—13317-10) **BWR blowdown heat transfer tenth quarterly progress report covering October 1—December 31, 1974.** (General Electric Co., San Jose, Calif. (USA). Boiling Water Reactor Systems Dept.). Jan 1975. Contract AT(04-3)-189. 75p. Dep. NTIS $5.50.

Blowdown Heat Transfer (BDHT) testing with the first 49-rod bundle has been completed. Data from seven BDHT tests are reported. Conclusions are drawn regarding the effects of variation of several independent parameters. The second 49-rod bundle has been installed in the Two-Loop Test Apparatus (TLTA) in preparation for the second series of BDHT tests. (15 references) (auth)

3282 (HEDL-TC—274(DR)) **Analyses of steel liners on concrete structures.** Polentz, L.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jun 1975. Contract AT(45-1)-2170. 149p. Dep. NTIS $7.00.

A post-accident-heat-removal structural effects analysis for the steel liner in the FFTF concrete containment structure is presented. (JWR)

3283 (HEDL-TME—75-60) **Postaccident heat removal assessment for the FFTF.** Armstrong, G.R. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Nov 1974. Contract AT(45-1)-2170. vp. AT.

An assessment of the potential for safely removing the residual heat generated by fission product decay after postulated hypothetical core disruptive accidents was performed using available analytical and experimental data. The resultant structural configuration, flow conditions, and core debris distribution and characteristics were the major areas addressed. The results confirm that 100 percent of the dispersed core resulting from the postulated initiating HCDA events in the FFTF can be adequately cooled and permanently retained in the reactor vessel. (auth)

3284 (LA—6005-MS) **Application of a drift-flux model to flashing in straight pipes.** Hirt, C.W.; Romero, N.C. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1975. Contract W-7405-Eng-36. 16p. Dep. NTIS $4.00.

A new computer program, SOLA-OF, has been written to solve the unsteady, two-dimensional equations of motion for a two-

phase mixture. The equations solved are based on the drift-flux approximation and include a phase transition model and a general drift velocity calculation. The SOLA-DF code is used for a study of the blowdown of straight pipes initially filled with water at high temperature and pressure. Computed results are presented that show the relative importance of phase transition rates, pipe friction, drift velocity magnitude, and other model variations. The computed results are also compared with experimental data. 7 references. (auth)

3285 (ORNL-TM—4712) **Simulation of nuclear fuel rods by using process computer-controlled power for indirect electrically heated rods.** Malang, S. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 63p. Dep. NTIS $5.45.

An investigation was carried out to determine how the simulation of nuclear fuel rods with indirect electrically heated rods could be improved by use of a computer to control the electrical power during a loss-of-coolant accident (LOCA). To aid in the experiment, a new version of the HETRAP code was developed which simulates a LOCA with heater rod power controlled by a computer that adjusts rod power during a blowdown to minimize the difference in heat flux of the fuel and heater rods. Results show that without computer control of heater rod power, only the part of a blowdown up to the time when the heat transfer mode changes from nucleate boiling to transition or film boiling can be simulated well and then only for short times. With computer control, the surface heat flux and temperature of an electrically heated rod can be made nearly identical to that of a reactor fuel rod with the same cooling conditions during much of the LOCA. A small process control computer can be used to achieve close simulation of a nuclear fuel rod with an indirect electrically heated rod. (auth)

3286 (ORNL-TM—4980) **LMFBR safety and core systems programs. Progress report for January—March 1975.** Fontana, M.H.; Wantland, J.L. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 131p. AT.

Progress is reported for the following activities: analysis and data evaluation of flow-coastdown tests; water system mockup of the Fuel Failure Mockup (FFM); development of detection methods for flow and blockage phenomena; FFM facility operations; and LMFBR electric heater and LWR fuel pin simulator development. (JWR)

3287 (ORNL-TM—5021(Vol.1)) **Quarterly progress report on reactor safety programs sponsored by the NRC division of Reactor Safety Research for April—June 1975. I. Light-Water-Reactor Safety.** (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 108p. Dep. NTIS $5.45.

Progress is reported in the following areas of study: blowdown heat transfer; fission product beta and gamma energy release; and zirconium--water oxidation kinetics. Operations at the Nuclear Safety Information Center are reviewed. Planned multirod burst tests, LWR fuel fission product release studies, and zircaloy cladding creepdown and collapse investigations are described. (DCC)

3288 (ORNL-TM—5021(Vol.2)) **Quarterly progress report on reactor safety programs sponsored by the NRC division of reactor safety research for April—June 1975. II. Heavy-Section Steel Technology Program.** Whitman, G.D. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 77p. Dep. NTIS $5.45.

Information on the heavy-section steel technology program for water-cooled reactor pressure vessels is presented concerning fracture mechanics analyses and investigations, effect of high-temperature primary reactor water on the subcritical crack growth of reactor vessel steel, investigations of irradiated materials, pressure vessel investigations, thermal shock investigations, and weld heat-affected-zone cracking. (DCC)

3289 (ORNL-TM—5021(Vol.3)) **Quarterly progress report on reactor safety programs sponsored by the NRC Division of Reactor Safety Research for April—June 1975. III. Liquid-metal-cooled fast breeder reactor safety.** Fontana, M.H.; Kress, T.S. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 51p. Dep. NTIS $5.45.

Information on the LMFBR reactor safety program is presented concerning radionuclide release and transport as a result of reactor events including the hypothetical core-disruptive accident. A capacitor discharge vaporization technique is being developed for generating electrical energy directly in LMFBR fuel that will produce HCDA-like fuel disassemblies. The scoping tests for this technique are continuing with two additional sets of experiments consisting of five tests each. The results and analyses of these tests are reported. (auth)

3290 (ORNL-TM—5021(Vol.4)) **Quarterly progress report on reactor safety programs sponsored by the NRC Division of Reactor Safety Research for April—June 1975. IV. High-temperature gas-cooled reactor program.** Sanders, J.P. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 17p. Dep. NTIS $4.00.

Digital computer codes for simulating the dynamics of HTGR components and systems were developed further. Component simulations for use in the overall NSS simulation have been completed and are operational for the core, steam generator, and turbine-generator, and initial runs have been made with a coupled core-steam generator model. Component models were also completed for the Core Auxiliary Heat Exchanger (CAHE) and Core Auxiliary Cooling Tower (CACT). Work continued on implementing the RECA code on the ORNL IBM 360 computers. 6 references. (auth)

3291 (ORNL-TM—5126) **Application of ALAP concept to exposure of workers at light-water reactors.** Dickson, H.W.; Cottrell, W.D.; Jacobs, D.G. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 48p. Dep. NTIS $5.45.

The application of the as-low-as-practicable (ALAP) philosophy to radiation exposure of workers at light-water reactors (LWR's) has recently received increased attention. The purpose of this project is to investigate the means by which occupational exposure at operating LWR's can be reduced to the lowest practicable levels. Nine such LWR stations, including 16 operating reactors, have been studied in phase I of the project to identify significant sources of exposure and to determine the magnitude of the exposures. A complete site review consists of compiling information from safety analysis reports (SAR's), plant technical specifications, and radiation exposure records and then making an on-site visit for discussions with plant personnel, observation of procedures, and measurement of radiation levels. In phase II, specific problem areas are being studied in-depth with regard to corrective measures to reduce exposure. Information has been collected on solving the problem of exposure from valve maintenance and repair. These corrective measures will be evaluated with respect to ease of application and cost effectiveness. The results of this study will serve as technical backup for the preparation of regulatory guides. (auth)

3292 (SAND—75-5987) **How should a loss of coolant accident be studied.** Steck, G.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 9p. (CONF-751113—1). Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

The development of a Monte Carlo model to analyze water-cooled reactor LOCA conditions is described. (DCC)

3293 **Rasmussen on reactor safety.** Rasmussen, N.C. (Massachusetts Inst. of Tech., Cambridge). *IEEE Spectrum;* **12**: No. 8, 46-55(Aug 1975).

A discussion is presented of the methodology employed in the reactor safety study which formed the basis of the WASH-1400 report. A brief discussion is also presented of risks outside the scope of the WASH-1400 report. These include hazards in shipping, waste disposal, sabotage, and theft of fissionable material. (DG)

ENERGY STORAGE

PUMPED HYDRO

3294 (AECL—4926) **Review of pumped energy storage schemes.** Unsworth, G.N. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Jul 1975. 56p. Dep. NTIS (US Sales Only) $5.50. AECL $1.50.

Pumped energy storage will become an attractive consideration for utilities as their installed nuclear generating capacity increases to the point that it exceeds the minimum power demand. A utility will wish to operate its nuclear units at high load factors because of their high capital costs and low fuelling costs. In addition, the cost of nuclear units will increase if they must be designed for load following. It is evident that alternative methods of coping with load changes should be considered. A summary is given of energy storage systems that are available and might prove economically attractive. The advantages and disadvantages of each scheme and a comparative cost study are presented. The energy storage schemes considered are: pumped Water Storage; steam Accumulators; storage of Boiler Feedwater (in caverns and above ground); and compressed Air in Caverns (for Gas Turbines). The cost data for the storage systems studied are used to determine the

maximum cost for any other method of energy storage if it is to be considered economically attractive. The results of the cost analysis indicate that boiler feedwater storage in caverns and pumped water storage are competitive as the most economical scheme. Geological and environmental considerations would likely have a major influence on the choice of one of these two systems. All systems studied were sufficiently high in cost to suggest there is adequate incentive for investigating and probably developing reactors withload following capabilities. At the same time, it is evident that, as the cost of fossil fuels increases, it will become attractive to build and operate energy storage schemes. (auth)

THERMAL

3295 (ORNL-HUD-MIUS—23) **MIUS technology evaluation: thermal energy storage materials and devices, August 1975.** Segaser, C.L. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 65p. Dep. NTIS $5.45.

The generation of electricity by an onsite power plant in a modular integrated utility system (MIUS) results in a considerable amount of waste heat energy being released from the prime-mover coolant system and exhaust gases, which can be effectively utilized for domestic space and water heating and, with less efficiency, for domestic air conditioning by use of an absorption chiller. If the amount of waste heat that can be recovered at any instant does not closely match the heat demand, excess heat must be rejected either to the environment or stored until it is required; a heat deficiency must be made up from storage or an auxiliary boiler. An evaluation is presented of the technologies relevant to the design of thermal energy storage (TES) devices and the selection of TES materials for application in a MIUS. Several thermal energy storage materials are commercially available in large quantities, are relatively inexpensive, and have properties which make them suitable for use in a MIUS. The techniques for thermal energy storage may involve the sensible heat of water or one of the available nonporous solids, or the latent heat of fusion of one of the available phase-change materials (PCMs). The conclusion is that water is a logical choice for thermal energy storage in a MIUS. This choice is based partly on the fact that water is a low-cost material. Also, because water is the most likely thermal energy conveyance medium between a MIUS district heating and cooling plant and the point of use, the TES containment unit can be a simple large district storage tank that does not require an intermediate heat exchanger. (auth)

BATTERIES

DESIGN AND DEVELOPMENT

3296 **Secondary electrochemical power-producing cells having mixed cathode composition.** Gay, E.C.; Shimotake, H.; Cairns, E.J.; Walsh, W.J. (to Energy Research and Development Administration). US Patent 3,884,715. 20 May 1975. Filed date 23 Feb 1972. 10p.

The anode is a molten alkali metal such as Li, and the electrolyte contains alkali metal ions. The cathode is comprised of a mixture of a chalcogen and a substance which reduces the activity of the chalcogen in the electrolyte. The cell lifetime is increased because transfer of the chalcogen from the cathode to the anode is inhibited. The chalcogen may be S or Se; and the other substance, Tl, As, Pb, or Al. (RWR)

APPLICATIONS

3297 (UCRL—52000-75-9, pp 20-25) **Lithium—water—air batteries for automotive energy.** Sep 1975.

In Lawrence Livermore Laboratory energy and technology review.

Electric propulsion is a possible alternative to the internal combustion engine. The electric vehicle, energized by coal- or uranium-fueled electric power plants, could be a multifuel, nonpetroleum automobile. The electrics' viability, however, depends on developing an economical battery system with the power and energy densities needed for acceptable performance. Only two batteries presently exist (molten-salt and lithium--water) that are competitive with the internal combustion engine in terms of specific power and energy. Based on recent feasibility studies, the conclusion is reached that the lithium--water--air battery, an adaptation of the lithium--water battery developed at Lockheed Aircraft, could make the electric vehicle practical. The battery uses a lithium metal anode and an inert cathode at which atmospheric oxygen is used. The lithium--oxygen couple results in a cell voltage of 2.6 V at 0.1 A/cm^2. This high cell voltage, combined with low internal resistance and low reactant weights, makes possible a battery of very high energy and power densities for use in a full-performance electric vehicle. (4 figures, 1 table) (auth)

ENERGY MANAGEMENT AND CONSERVATION POLICY

3298 (ERDA—79) **International energy analysis. Proceedings of a seminar on international energy analysis held June 9—10, 1975, in Washington, D.C.** (Energy Research and Development Administration, Washington, D.C. (USA); National Science Foundation, Washington, D.C. (USA)). 1975. 228p. Dep. NTIS $7.60.

The objective of the first International Energy Analysis Seminar was to bring together information specialists, analysts, and policymakers actively involved in the formulation of international energy policy. There were representatives from the Federal Government, industry, and universities, along with others interested in identifying policy problems, developing options, clarifying the issues, understanding the possible consequences of actions, and making the information available to the policymakers. Separate abstracts are included here for the three sessions: Policy Issues of Concern to Government Decision-Makers; Analytical Capabilities; and Information Needs and Availability. The discussions following each session are included after the formal presentations. (MCW)

3299 (ERDA—79, pp 1-64) **Policy issues of concern to government decision makers.** 1975.

From Seminar on International Energy Analysis; Washington, DC (9 Jun 1975).

In International energy analysis.

International energy and energy R and D issues were discussed by five decision makers, who noted typical time frames, types of information, and analytical methods anticipated to resolve these issues. Speakers were: Clement B. Malin, International Energy Affairs, Federal Energy Administration; Norman Terrell, Office of Policy Regulation, Nuclear Regulatory Commission; Steven W. Bosworth, Office of Economic and Business Affairs, Department of State; Jon M. Veigel, Energy Project Leader, Office of Technology Assessment; and John P. Andelin, Administrative Assistant to Congressman Mike McCormack. (MCW)

3300 (ERDA—79, pp 65-154) **Analytical capabilities.** 1975.

From Seminar on International Energy Analysis; Washington, DC (9 Jun 1975).

In International energy analysis.

At this session analysts discussed the types of problems to which various analytical techniques (including international energy technology and economic models) can be productively applied. The session was user-oriented rather than a detailed discussion of methodology. Speakers were: Henry D. Jacoby, Alfred P. Sloan School of Management, Massachusetts Institute of Technology; Kenneth C. Hofman, Dept. of Applied Science, Brookhaven National Lab.; Merih Celasun, Senior Economist, World Bank; Leo A. Rapaport, Head, LORENDAS Project, Virginia Polytechnic Institute and State University; Ali Ezzati, International Energy Modeling and Forecasting Division, Federal Energy Administration; and Eugene A. Eschbach, staff scientist, Battelle-Pacific Northwest Labs. (LMT)

3301 (ERDA—79, pp 155-219) **Information needs and availability.** 1975.

From Seminar on International Energy Analysis; Washington, DC (9 Jun 1975).

In International energy analysis.

The requirements, availability, deficiencies, and reliability of data bases and other information relating to international energy and energy R and D were discussed in this session. Methods by which users access data as well as means used by specialists to obtain and update data were described. Speakers were: Roger S. Carlsmith, Energy Division, Oak Ridge National Lab.; W. Calvin Kilgore, Operations Research Analyst, Federal Energy Administration; Joel Darmstadter, Senior Research Associate, Resources for the Future, Inc.; Duane E. Deonigi, Manager, Economic Analysis, Battelle-Pacific Northwest Labs.; Richard L. Gordon, Professor of Mineral Economics, Pennsylvania State University; and David E. Bost, Technical Information Center, U.S. Energy Research and Development Administration. (LMT)

RESEARCH AND DEVELOPMENT

3302 (UCRL—52000-75-9) **Lawrence Livermore Laboratory energy and technology review.** Carr, R.B.; Barnett, J.M.; Berlo, R.C.; McCaleb, C.S.; Prono, J.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1975. Contract W-7405-Eng-48. 30p. Dep. NTIS $4.00.

Five articles summarizing recent work done at Livermore are compiled. They include an analysis of research and development priorities, methanol from in situ coal gasification and its uses as an automotive fuel, and Li-water-air batteries for electric vehicles. Separate abstracts were prepared for each article. (JSR)

3303 (UCRL—52000-75-9, pp 1-8) **Energy research and development priorities.** Sep 1975.

In Lawrence Livermore Laboratory energy and technology review.

This Laboratory's analyses of national energy research and development priorities indicate that transportation research and development should be accorded the highest priority. The focus should be on better methods for obtaining fuels as well as better utilization of fuels in improved vehicles. These conclusions are based on several LLL studies establishing four major premises. First, transportation is essential to the nation's welfare, and our chosen national mode of transportation--supported at nearly all economic and societal levels--is the automobile. Second, our transportation system is almost totally dependent on oil, although domestic supplies are inadequate and foreign supplies are not assured. Third, transportation, unlike the nation's other consuming sectors (industrial, residential, commercial), presently has no competitive energy alternatives; these must be developed. Finally, although there are promising research and development possibilities for alternative fuels and vehicles, these are now underfunded and need considerably more support. (auth)

SYSTEMS STUDIES AND TOTAL ENERGY

3304 (ANL/AA—1) **Regional energy modeling: an evaluation of alternative approaches.** Cohen, A.S.; Costello, K.W. (Argonne National Lab., Ill. (USA)). Jun 1975. 148p. Dep. NTIS $5.45.

Eight comprehensive energy models, representing the current state of the art, are evaluated and their ability to analyze present energy issues is discussed. Initially, the criteria on which the evaluations are based are defined and, in the process, a conceptual model that contains the essential characteristics of a regional energy model is generated. The criteria are disaggregated into three components: model comprehensiveness, economic aspects, and model capabilities. Each of the models are evaluated individually and the modeling techniques used are compared. The models are categorized into "local impact" and "national synthesis" groups. The local impact group can be applied to state or substate areas. Their forte is the degree of the end-use detail they provide. One of their shortcomings is the inability to analyze the regional impact of national energy policies. The "national synthesis" models are designed to analyze the impacts of national policies on the availability and/or consumption of energy on a national or regional basis. It is concluded that none of the models evaluated satisfies all of the criteria defined for energy models. The more important shortcomings are the inadequate consideration of the competition between production and/or consumption regions, and the lack of integration of the energy economic systems with the rest of the economy. Recommendations for future research and model development are presented. The primary goal of these future research efforts is to alleviate the shortcomings of existing techniques. (auth)

3305 (BNL—20083) **Methodology of technology analysis with application to energy assessment.** Hoffman, K.C. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. (CONF-751106—12). Dep. NTIS $4.25.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

In view of the significant social and economic consequences of technical change, it is important for the engineering community to provide sound technical inputs to the formulation of national policies. A methodology designed specifically for this purpose for application to large-scale technical systems is described and illustrated by application to the U.S. energy system. This methodology, Technology Analysis, uses three basic building blocks: a structural description of the system, an optimization technique for system synthesis and design, and a model of the economy within which technical detail and social structure may be expressed. The approach is general and is adaptable to other important technology policy areas including materials, agriculture, and transportation. (auth)

3306 (ORO—4398-3, pp 205-236) **Summaries of theory. A. Energy quality interactions of sunlight, water, fossil fuel, and land.** Odum, H.T. (Univ. of Florida, Gainesville). 1975.

In Energy models for environment, power, and society.

In order to understand the potentials of what kind of energy system maximizes work by man and by nature, what kinds of energy interactions generate a vital economy, and the carrying capacity of these energy systems for man, thirteen energy quality principles are illustrated with systems energy diagrams using the energy language symbols. Specific energy quality surveys are discussed for sunlight, water, and fossil fuel; Earth cycles and man; and dispersed solar heat. (MCW)

3307 (ORO—4398-3, pp 237-254) **Summaries of theory. B. Energy quality and carrying capacity of the Earth.** Odum, H.T. (Univ. of Florida, Gainesville). 1975.

In Energy models for environment, power, and society.

A theory of energy quality hierarchy suggests the human role on Earth and the carrying capacity of the world for man. The middle-sized realms of energy are examined, in which civilization exists to learn how energy flow operates environments, economics, and the community of nations. A chain of energy transformation is illustrated with sunlight. Sunlight and dilute heat gradients are low-quality energy; fossil fuels, rainwaters, animal carnivores, storms, and human food products are high quality energies; elevated mountains, biological genetic processes, and human intellectual activities are very high quality energy flows. An energy quality factor is defined as the ratio of calories of energy of sunlight necessary to be converged in support of the calories of high-quality energy developed. Simplified energy chains in support of man are schematically shown. Net energy for man, energy too rich to use such as nuclear fusion, and the renewing of fuels and minerals are subjects briefly discussed. It is stated that it may be man's role as a programmable servant of nature to facilitate and maximize the flow of energies producing growth from storages when it is possible, and evenly distribute steady states when the only available energy flows are steady. (MCW)

3308 (ORO—4398-3, pp 255-293) **Summaries of theory. C. Energy analysis as a common basis for optimally combining man's activities and nature or what has Mother Nature done for you lately (or you for her).** Kylstra, C.D. (Univ. of Florida, Gainesville). 1975.

From Proceedings of 2. National Conference on Corporate Social Policy; Chicago, IL, USA (3 Oct 1974).

In Energy models for environment, power, and society.

The difficulty of assigning dollar values to the free services performed for our society by nature is overcome by using another measure that is common to both man's systems and the natural systems, and by considering the total combined system of man and nature. Since no activity or change of state of any kind occurs without the degradation of potential energy into heat, the amount of energy flowing through any system or combination of systems can be used to measure the useful work being accomplished, whether by plants, animals, machines or other, and the inter-relationship between the systems, if all work is converted to a common reference concentration. If left alone, systems will optimize themselves to maximize the useful work possible under externally imposed constraints. If abundant energy is available, then rapid growth, low efficiencies are required to maximize power and to outcompete and out-survive other systems. If energy is limited, then survival requires minimizing waste, leading to high efficiencies and complex inter-relationships between specialists or subsystems, to extract every bit of useful work out of the available energy. Unfortunately, it is possible to suffer traumatic, violent oscillations as a system is changing over from unlimited to limited energy rather than experiencing a smooth transition. The actual path followed by the system is under the control of the decision makers, whereas the eventual state reached by the system may not be. The best system for man requires that both man's activities and other natural systems be considered as one system, so that balanced decisions can be made to maximize the survival of the combined system. Considering only man's activities results in a poorer economic condition for man than if the combined system is considered. (Summary)

3309 (ORO—4398-3, pp 294-318) **Summaries of theory. D. Combining energy laws and corollaries of the maximum power principle with visual systems mathematics.** Odum, H.T. (Univ. of Florida, Gainesville). 1975.

From ECOSYSTEM Analysis and Prediction. Proceedings of a Conference on Ecosystems; Alta, UT, USA (1 Jul 1974).

In Energy models for environment, power, and society.

The author states that special opportunity exists for the union of ecology and mathematics in further development of comprehensive visual diagrammatic mathematics. Forrester's diagrams, Levin's loop analysis, and Odum's energy diagrams were some of

the symbolic systems used at this conference. He further states that the best features of all diagrammatic systems languages should be combined; synthesis of diagrams provides an opportunity to include energy constraints. If energy flows generate order and process, energy diagrams are a natural means of generalizing models of man and nature so as to include natural aggregations and processes. In this paper, pictorial circuit language is used to discuss the energy laws that control real systems and thus should constrain models. Energy circuit language is used to help retain the deterministic constraints of energy with survival criteria and to bring the energy know-how of other size levels of study into effective use for the environmental scale. Basic patterns are shown schematically of order built by energy flow operating with three energy principles and their corollaries. The visual representation of energy laws is schematically shown. The first energy law states that all energies pass from the external source into storages leaving the system as energy export. The second energy law states that all energy flowing in a process must have part of its energy degraded in concentration so as to increase the entropy of the environment mainly by dispersion of heat. The third energy principle used to develop visual mathematics was first stated by Lotka in 1924: that the maximum power principle combines natural selection with energetics and general systems thinking. The maximum power principle indicates that systems survive that maximize their power utilization. Corollaries are discussed and diagrammatically shown. (MCW)

3310 (ORO—4398-3, pp 361-399) **Summaries of theory. G. Energy, value, and money.** Odum, H.T. (Univ. of Florida, Gainesville). 1975.

In Energy models for environment, power, and society.

The creation of energy flow diagrams leads to some new understandings about the principles of energy and the relationship of these principles to value, to money, and to a more quantitative understanding of the varying qualities of different energy sources in support of useful work. A narrative is developed that starts with the first and second energy laws and the Lotka principle of natural selection for systems with maximum power. The integration of these concepts shows how the requirement for generation of order is as much a necessary part of energy laws as the degradation of order. From these concepts a characteristic closed, autocatalytic loop of high-quality energy interacting with low-quality fuel energy is recognized as a necessary part of all systems that undergo natural selection. This loop is accompanied by a circulation of money where human economic affairs are concerned. The paper reviews basic energy principles, restates some relatively new and original propositions about energy, illustrates use of energy diagrams to represent complex systems, and introduces energy cost - benefit procedures. (auth, Introduction)

SUPPLY, DEMAND, AND FORECASTING

3311 (AAEC/IP—2) **Perspectives in energy requirements of mankind.** Symonds, J.L. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Aug 1975. 34p. Dep. NTIS (US Sales Only) $4.75.

The growth of energy demand from the nineteenth century to the present and its likely future development are described, for the interested layman, in the context of the changing pattern of resource use. The availability and distribution of the renewable and nonrenewable resources of energy, which will provide for the future, show that developed and developing countries will incur supply problems in the decades ahead unless the potential of all energy reserves is tapped. Factors such as the market penetration of new resources and the depletion of resources are outlined. It is pointed out that coal may be used increasingly for some time, but nuclear energy is the only other energy form that is immediately available and that can be utilized commercially. Nuclear energy will be needed even if countries are prepared to cut back to low growth rates in energy use. It is suggested that lower growth rates may well be necessary in the next twenty to thirty years, since it takes this time to bring new alternative technologies into commercial use, and a further similar period will be required to achieve significant resource substitution. (auth)

3312 (BNL—20323) **Pennsylvania energy system.** Rubin, E.S.; Edelston, B.S.; Gunwaldsen, D.S.; Notary, K.E. (Carnegie-Mellon Univ., Pittsburgh, Pa. (USA). Environmental Studies Inst.). Jun 1975. 122p. Dep. NTIS $6.50.

A detailed analysis is presented of energy supplies and demand in Pennsylvania for the base year 1972. Supplies of coal, oil, natural gas, nuclear, and hydroelectric energy sources are identified and traced through the fuel cycle from extraction or import receipt through refining, transport, conversion, and end use, including exportation. Energy-consumption patterns are presented for five Pennsylvania demand sectors including electric utilities, industry, commerce, residences, and transportation systems. Efficiencies are presented for major energy conversion processes in the state, and energy use by each sector is disaggregated to estimate ultimate end-use according to specific groups or functions. The report also discusses the limitations of existing data sources as they affect the quality and level of available detail of energy flow estimates for various parts of the fuel cycle. Results of the present study can provide a useful tool for energy-related policy analysis in Pennsylvania, particularly when coupled with an auxiliary data base describing key technological, social, economic, and environmental factors associated with unit energy flows in any part of the system. While such an auxiliary data base does not presently exist for Pennsylvania, systems such as the comprehensive file developed nationally by Brookhaven National Laboratory can serve as a ueful starting point for assessing energy policy impacts and alternatives for Pennsylvania. (auth, Summary)

3313 (BNL—20427) **Energy supply and demand in the Northeast United States: 1972.** Lee, J. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1975. 86p. Dep. NTIS $5.45.

A comprehensive description of the energy supply and demand pattern in the Northeastern U.S. in 1972 is presented. The region covers New England (Region I), New York (Region II), Pennsylvania, New Jersey, Delaware, Maryland, and District of Columbia (Region III). The Reference Energy Systems (RES) defined in this report describe major components in the energy system, specifying resource consumptions, fuel transportation, conversion processes, and end use for each region. Section II discusses the RES methodology and the results derived. Sections III and IV describe the primary sources of information and methods used to estimate various end uses of energy in the residential, commercial, industrial, and transportation sectors. These end use demands specified by sector and fuel type are necessary input data to construct the Reference Energy Systems. Section VII analyzes the fuel consumption and energy generated by the electric utility sector in the region. Section VIII provides data on the regional energy supply systems. Included in Appendix A is a set of Fuel Mix Tables that are designed for future energy demand projections. Appendix B contains the regional socio-economic data used in the study. Appendix C displays the conversion factors and energy equivalents of various fuel types. (MCW)

3314 (LA—6122-MS) **Rocky Mountain energy 1974: flows, employment, prices.** Barrett, R.J.; Beyer, W.A.; Kolstad, C.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-eng-36. 49p. Dep. NTIS $4.00.

Presented is a state-by-state study of the energy system in the Rocky Mountain region for 1974. Detailed data on fossil-fuel and electricity production, transportation, importation, exportation, conversion, and consumption have been compiled for the states of Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming, singularly and as a unit. Three types of information on the regional energy system are given: (a) quantities of energy produced, transported, etc., (b) employment in these activities, and (c) contribution to the final energy price due to these activities. (auth)

3315 (ORNL-NSF-EP—87) **Electricity demand by manufacturing industries in the United States.** Chern, W.S. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 74p. Dep. NTIS $5.45.

The study examines the important trends related to the manufacturing consumption of electricity and to estimate the demand relationships for groups of and selected individual manufacturing industries. The study focuses on the estimation of price response, interfuel substitution, and the impact of technological change. Sixteen major manufacturing industries at the Standard Industrial Classification three-digit level were selected for analysis. The study shows that industrial demand for electricity is price elastic in the long run. Furthermore, natural gas, oil, and coal were found to be significant substitutes for electricity. However, the pattern of the interfuel substitution varies from industry to industry. The results also show that technological progress has reduced the manufacturing usage of electricity at an annual rate of 1.2%, while ignoring other factors over 1958—1971. (auth)

3316 (ORO—4398-3) **Energy models for environment, power, and society.** Odum, H.T.; Kylstra, C. (Florida Univ., Gainesville (USA). Dept. of Environmental Engineering Sciences). 1975. Contract AT(40-1)-4398. 376p. Dep. NTIS $11.75.

This is an annual report and also a general contract summary of work on the energy models, concepts, and simulations for understanding the systems of environment, power, and society. Included is a general narrative of project work, summary of development of energy language and application of its models, simulations of systems of city and county size, development of net energy and

energy quality theory, use of models and net energy theory to evaluate aspects of national policy, and aspects of interface between project work and national and state policy makers. Results this year include modeling and simulation of energy basis for Miami, Florida; net energy of coal, oil shale, solar water heating, and present nuclear power plants; and papers written on the theories of energy quality, energy theory of value, and investment ratio for estimating economic viability. (auth) A separate abstract was prepared for each of ten major sections. (MCW)

3317 (UCID—3735) **Is a crystal ball better than a regression analysis. A review and interpretation of energy projections.** Benenson, P.; Levy, D.; Merrill, D.; Risser, T.; Ruderman, H.; Simmons, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 29 Oct 1973. 47p. Dep. NTIS $5.00.

Several energy projections and the uses to which they were put were examined; some were old enough to allow comparisons of their predictions with subsequent events. Methods and assumptions involved in making projections are described. Two 1972 projections are critically reviewed—those of the National Petroleum Council and the Department of Interior, which employ essentially the same methodology and assumptions as the earlier projections. Both studies assume that current trends in life style will remain unchanged and focus on the supply side. There is no prediction of what demand for energy actually will be, only a projection of what consumption would be if the past trends of consumption continue. The two reports arrive at similar conclusions about future levels of energy consumption. Based upon what these reveal, some conclusions are made about the "energy crisis". Also examined here are studies by Brookhaven National Laboratory and Lawrence Livermore Laboratory which attempted to assess the impact of new technologies on the overall supply and consumption of energy. These studies employ projections of energy consumption to assign priorities for R and D investment. (Ed. note: this report just became publicly available and, although slightly old, is felt worthy of announcement.) (MCW)

3318 (UCID—3760) **Progress report on the manpower constraints on energy plant construction and operation.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 30 Jun 1975. 103p. Dep. NTIS $6.50.

This multi-regional study examines whether trained manpower in all required operations will be available in adequate numbers to construct and operate the energy plants implied by the consumption forecasts. A preliminary working model is constructed that simulates the effects of various economic conditions and policies. The first computer results project the levels of gross output necessary to satisfy the projected levels of final demand for 1980. The levels of employment by occupation and the energy requirements necessary to produce these outputs have been projected. The resulting levels of final demand, gross output, employment by occupation, and energy levels were computed and are presented. The limitations imposed by manpower and industrial capacity were simulated, but accurate constraints for the energy sectors have not yet been formulated. Five results are reported in detail: development of a theoretical model to analyze the problem of manpower constraints; assembly of a data base to test the model; construction of working computer programs that embody the relationships of the model and calculate results for analysis; preliminary empirical results from testing the model with existing data; and a detailed plan for improving the accuracy of the results. (34 references) (MCW)

POLICY, LEGISLATION, AND REGULATION

3319 (BNL—20510) **Energy Institute for Developing Countries: a working paper.** Palmedo, P.F.; Nathans, R. (Brookhaven National Lab., Upton, N.Y. (USA); State Univ. of New York, Stony Brook (USA)). May 1974. 12p. Dep. NTIS $4.00.

The volatility of energy prices, as well as the precariousness of international energy supply, is forcing many developing countries to consider new ways to satisfy their energy needs over the next several decades. As a result it is likely that major changes in energy production - distribution systems will occur in large numbers of these countries. A necessary component of the important decisions these countries must make, e.g., with respect to changes in plans for their economic development or the introduction of new technologies, is the need to assess the alternatives and plan for their country's current and future energy needs. This working paper discusses the establishment of an Energy Institute for Developing Countries, whose major function would be to assist and work with interested countries in the performance of energy planning and assessment analyses. Other areas to be covered by the Institute include: (1) preparation of methodologies for evaluation and assessment of new technologies for individual countries; (2) generation of data bases of technical coefficients; (3) provision of user manuals, training of technical personnel and extensive consultations with appropriate government officials in developing countries; and (4) support to agencies and organizations in the U.S. concerned with energy problems in developing countries. The paper discusses the need for and characteristics of a comprehensive energy planning and assessment framework, and a scheme for micro and macro assessments of alternative energy technologies. It also lists a series of specific mechanisms for developing appropriate models and data bases, and transferring the results to interested developing countries. (auth)

3320 (ORNL-NSF-EP—89) **Electricity demand: Project Independence and the Clean Air Act.** Chapman, L.D.; Akland, G.G.; Finklea, J.F.; Larsen, R.I.; Mount, T.D.; Nelson, W.C.; Quigley, D.C.; Wilson, W.C. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 69p. Dep. NTIS $5.45.

This study was prepared for the Task Force on Conservation and Fuel Supply of the National Power Survey. The investigation analyzed policy issues facing electric utilities, consumers, and Federal and state agencies. Conclusions are: 1. Demand growth should proceed at a lesser rate than in the past. The 1980 consumption may be 2.2 trillion kWh, rather than the 3.1 trillion kWh projected by the National Electric Reliability Councils. 2. Conservation programs should be continued and expanded, and applied to every jurisdiction level and consumer group. 3. Natural gas use should be promoted for home and business heating where possible. Natural gas use in power generation and (in general) in industrial boilers is less desirable. The expansion of home and office electric resistance heating should be discouraged. 4. Rate structures should not be inverted, but rate increases should be passed along to consumers to reduce average price differences within classes and between classes. 5. The primary ambient air quality standards in the Clean Air Act should be implemented. (auth)

ENVIRONMENT

3321 **Citizens' workshops on Energy and the Environment.** Akers, L.K. (Univ. of Tennessee, Oak Ridge); Yegge, J.F. *Nucl. Technol.*; **27**: No. 1, 143-147(Sep 1975).

The Citizens' Workshops on Energy and the Environment program was designed to heighten citizen awareness of the many dimensions of the energy problem. It involved the development of a novel educational device-the Energy-Environment Simulator-and appropriate visual materials for a general audience. The workshops have been presented more than 1500 times and in virtually every state of the union. (auth)

ENERGY RESOURCES

3322 (CONF-750973—1) **Age of substitutability: or what do we do when the mercury runs out.** Goeller, H.E.; Weinberg, A.M. (Oak Ridge National Lab., Tenn. (USA)). [nd]. 50p. Dep. NTIS $5.50.

From 11. annual foundation lecture on a strategy for resources; Eindhoven, Netherlands (18 Sep 1975).

Man's long-term future may be perceived in two views: one, that the Earth's resources will soon be exhausted and will lead to the collapse of society, the "catastrophist" view; the other, the "cornucopian"are infinite—i.e., as society exhausts one raw material, it will turn to lower-grade, inexhaustible substitutes, settling into a steady state of substitution and recycle. This paper conceives the depletion of resources and substitution in three stages. Stage I is a continuation of the present pattern of use of non-renewable resources, persisting for perhaps another 30 to 50 years. In Stage II, lasting several hundred years, society will still depend on reduced C and H found in nature, i.e., coal; there will be little oil and gas, and people will begin to turn toward greater use of alloy steels (Al, Mg, and Ti). In Stage III, all fossil fuel will be gone; society will be based almost exclusively on materials that are virtually unlimited. It is believed that lifestyles in Stage III will not be drastically different from the present. The fission breeder, fusion (if feasible), or solar energy, in principle, could carry the energy budget in Stage III forever. It is concluded that for most of their uses, substitutes derived from infinite or near-infinite materials are available. Results are summarized for the case of mercury. Additional data are provided in four appendices. (MCW)

3323 (UCID—3711) **Program of geoscience research.** (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Feb 1975. 45p. Dep. NTIS $5.00.

An overview is presented of the accomplishments, present status, and plans of geoscience research to examine the physical and chemical behavior of geologic systems and their modification through engineering works. The structure of the LBL Program of research is as follows: Geologic Materials—rocks and minerals, brines, and rock-fluid systems; Geothermal Resources—igneous centers, regional geophysics, reservoir delineation, radioactivity, chemical composition, and reservoir dynamics; Fossil Energy Resources—petroleum recovery, thermal extraction, and coal particulates; Mechanics of Earth Systems—soils and soft rocks, gravity offshore platforms, and fractured rock masses; Seismic Hazards—soil-structure interactions and earthquake prediction. (MCW)

FOSSIL FUELS

COAL

3324 (ERDA—45(75/4)) **Fossil energy research program. Summary status report, fourth quarter FY75.** (Energy Research and Development Administration, Washington, D.C. (USA)). 15 Aug 1975. 102p. Dep. NTIS $8.25.

This document contains copies of summary charts depicting the Fiscal Year 1975 fourth quarter status of ERDA Fossil Energy Research Programs. These status charts are based both on planning material and on inputs received from organizations performing the planned research. The contents of this document, and those of its companion "Comprehensive Addendum," are the standard products of the Energy Research Program Information System (ERPIS), developed for management needs of the ERDA Fossil Energy Program. Sufficient summary material is presented to provide a general understanding of the current status of the Fossil Energy Research Program. With its companion "Comprehensive Addendum," a more detailed understanding of the current status of the parts of the program can be obtained including locations, schedules, funding, etc., for individual reported efforts comprising the program. (auth)

3325 (ORO—4398-3, pp 118-137) **Net energy analysis of the use of Northern Great Plains surface-mined coal in midwestern power plants.** Ballentine, T. 1975.

In Energy models for environment, power, and society.

This analysis is based on a methodology developed by Dr. H. T. Odum, Department of Environmental Engineering Sciences, University of Florida, for evaluating various energy alternatives and the effects of energy policy on the economy and environment. The methodology is based on two principles: (1) Lotka's Maximum Power Principle stating that those systems survive which maximize the processing of power available to them and distribute this power to effectively assure their long-range survival; and (2) the concept of net energy elaborated by Odum, i.e., the energy available from a source after all the energy costs associated with finding, producing, concentrating and upgrading, and delivering the energy to its final use site have been paid; the loss of natural energies due to the extraction and use of the energy source must also be deducted. The methodology indicates all energy inputs, identifying those obtained by money payment and those obtained free from the natural system. It also shows the interdependence of systems' components and takes account of all the laws of thermodynamics. The complete energy analysis of the Northern Great Plains surface-mined coal converted to electricity was calculated to determine its viability as an energy source and its relative competitive position with respect to other energy sources. Detailed calculations and results are presented in an appendix. (18 references) (MCW)

3326 **Clean fuels from coal for power generation.** Jones, J.F. (FMC Corp., Princeton, NJ). *Energy Sources;* **2**: No. 2, 179-202(1975).

From American Chemical Society Storch Award Symposium; Atlantic City, NJ, USA (11 Sep 1974).

There is a need today for more clean energy than ever before. Oil and gas shortages have made themselves felt during the past year, and these shortages will continue to worsen. Coal is available throughout the United States and can be that source of clean fuels required to make the country self-sufficient in oil and gas. A major impact can be made on oil and gas supplies by substituting in power plants clean fuels derived from coal. This can be done by converting high-sulfur coals into a fuel gas and/or oil of low-sulfur content to meet any environmental requirement. The Char-Oil-Energy Development (COED) process is one method for accomplising this conversion of coal to clean fuels. It has been developed by the FMC Corporation under contract to the Office of Coal Research (OCR), Department of the Interior. The technology from this OCR program, together with added technology on char gasification, can be adapted for scaling up to a commercially sized plant for generating clean fuels for the power industry. (auth)

NATURAL GAS

3327 (CONF-750861—1) **Implications of natural gas shortage for industrial demand and the environment.** Chern, W.S.; Gill, G.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 22p. Dep. NTIS $4.25.

From Annual meeting of American Agricultural Economics Association; Columbus, Ohio, USA (10 Aug 1975).

A model consisting of demand and price equations was estimated by techniques of error components and two-stage least squares. Thirteen manufacturing industries were selected for analysis. Results show that the deregulation of gas prices should be an effective means of reducing both future gas shortages and environmental degradation. (auth)

OIL SHALES AND TAR SANDS

3328 (ORO—4398-3, pp 33-117) **Preliminary net energy analysis of the production of oil from oil shale and the potential of oil shale as an energy source.** Gardner, G.M. 1975.

In Energy models for environment, power, and society.

A new method of energy modeling and energy cost accounting developed by Dr. H. T. Odum (University of Florida, Department of Environmental Engineering Sciences) is used to estimate net energies for oil shale. Three separate preliminary analyses utilizing varying data and/or assumptions were made. The first analyzed total net energy yields from the Bureau of Mines Oil Shale Research and Development Program from the program's inception to 1975 and assumed all production from this program was obtained at the BM Gas Combustion Retort Pilot Plant operations at the Anvil Point facility near Rifle, Colorado. The second analysis assumed a steady-state condition with the existing 150/ton calendar day retort being operated for an additional 20 years. ... A third analysis was made of the proposed 50,000-barrel-per-day facility utilizing data provided by the U.S. Department of the Interior. A macroscopic minimodel was prepared and evaluated including the estimated budgets of matter and energy for the system, aggregating details into a few major pathways to give a simplified overview perspective. (57 references) (auth, from Introduction)

NUCLEAR ENERGY

3329 (ORO—4398-3, pp 138-200) **Energy analysis of the U.S. nuclear power systems.** Kylstra, C.; Han, K. (Univ. of Florida, Gainesville). 1975.

In Energy models for environment, power, and society.

The feasibility and benefits of the nuclear system for our society are analyzed. The analysis is based on principles of general energy systems, as described by Dr. H. T. Odum, University of Florida. The method of analysis ties together all the important flows and interactions affecting the nuclear system, including energies expended in all parts of society for the system. The basic goal is to determine the net energy of the U.S. nuclear system. A secondary goal is to determine the accumulated energies spent or put into the nuclear system through 1972, as well as the production of energy by the nuclear system for use by society. This measure shows how large an investment has already been made, what the likely time frame is for the nuclear system to pay back its debt, and when it will start producing positive net energy for society. A third goal is to model the U.S. nuclear system, using a general energy systems theoretical model, to observe the dynamic behavior of society and the nuclear system in the future. Results show that energy gains (2.7) for the nuclear system are low compared to western coal (4.0), and existing fossil-fuel systems (8 to 10). It is indicated that the energy investment in the nuclear system will not be paid back until nearly the end of this century. If everything goes according to the schedule desired by the AEC, breeder reactors will begin to be important about that period. Thus, they will be consuming large amounts of energy for construction and creation, at the point when the light-water system will just be beginning to pay off. (22 references) (MCW)

HYDROGEN AND SYNTHETIC FUELS

3330 (FE—1808-1) **Preliminary analysis of direct resource requirements for three synthetic fuel scenarios.** Carasso, M.; Gallagher, J.M.; Sharma, K.J. (Bechtel Corp., San Francisco, Calif. (USA)). Jul 1975. 91p. Dep. NTIS $7.75.

A brief analysis is presented of the capital, manpower, and material resource requirements needed to implement the President's Energy Program of January 1975, the highlights of which were presented in the 1975 State of the Union message. Three separate scenarios for the development of a synthetic fuels industry to a level of 1 million bbl/day by 1985 are emphasized primarily. Because the work was carried out prior to the availability of a complete specification of the President's Energy Program, the analysis is based on a preliminary interpretation of the program. A model is presented for developing annual schedules for addition of energy facilities required to meet contemplated energy needs until 1995; specifically, the model is applied to two fuel mixes which represent perturbations of the base synthetic fuel scenario. (EJH)

UNCONVENTIONAL SOURCES AND POWER GENERATION

SOLAR

3331 (COO—2620-1) **Establishment of a solar energy research institute.** (National Academy of Sciences - National Research Council, Washington, D.C. (USA)). 1975. 50p. TIC.

The Solar Energy Research Institute (SERI) is to be established by ERDA to carry out the mandate of Congress expressed in Section 10 of Public Law 93-473. The role and internal structure of SERI are discussed at length along with the corporate structure and interface with ERDA. The criteria for location of SERI and the mechanics of site selection are announced. (WDM)

3332 (MTR—7067) **Industry opinions on the formation of Solar Energy Reserch Institute (SERI).** (MITRE Corp., McLean, Va. (USA)). Oct 1975. 59p. TIC.

Section 10 of Public Law 93-473 says that a Solar Research Institute (SERI) is to be established, but there the legislative prescription stops. To administer this provision of the law, the Energy Research and Development Administration (ERDA) is widely soliciting recommendations for the development of a SERI. The MITRE Corporation, under contract to ERDA, has sought to acquire and report a distinctly solar-energy-industry viewpoint. This paper summarizes the recommendations and caveats on the formation of the SERI obtained from a small sample of that industry. (auth)

3333 (ORO—4398-3, pp 19-32) **Evaluation of alternative solar water heaters.** Brown, S.; Zucchetto, J. 1975.

In Energy models for environment, power, and society.

Energy flows are quantified and capital requirements are discussed for the use of solar energy as an energy source for water heaters. The Miami-Dade County area in Florida, with an average incident solar radiation flux of 4500 kcal/m²/day, is used as a desirable area for evaluating the effectiveness of solar energy technology. Solar water heaters for a family of four using solar energy coupled with large-area collectors are evaluated; comparisons are made with electricity, gas, and wood. Results show that solar water heaters energetically outcompete both electrical and gas heaters. The margin of difference between the solar and gas heater is small, and solar capital requirements are larger. If gas heaters were replaced by solar heaters in Dade County, the capital would have to be taken out of other segments of the economy. (MCW)

3334 **SOLAR HEATED BUILDINGS: A BRIEF SURVEY.** Shurcliff, W.A. 11th. Edition. NP—20729. Cambridge, MA; United States of America (USA); Wm. A Shurcliff (1975). 172p. Wm. A. Shurcliff, 19 Appleton St., Cambridge, MA 02138 $8.00.

The survey includes data on 187 houses, schools, and commercial buildings that are partially or fully solar heated that did exist, do exist, or will be completed soon. Buildings in the U.S. are discussed by states and then structures in foreign countries are discussed. The total number of solar heated houses built in 1975 was 74; the total built prior to 1975 was 62. The 9th edition of the Survey was announced in EAPA 1 (11), Abst. 2210. (MCW)

GEOTHERMAL

3335 (CIRC—726) **Assessment of geothermal resources of the United States, 1975.** White, D.E.; Williams, D.L. (eds.). (Geological Survey, Washington, D.C. (USA)). 1975. 159p. U.S. Geological Survey, Reston, VA.

Six sections are presented along with an introduction, a summary discussion, and conclusions. A separate abstract is prepared for each. (LBS)

3336 (CIRC—726, pp 1-4) **Introduction.** White, D.E.; Williams, D.L. 1975.

In Assessment of geothermal resources of the United States, 1975.

The basis for a comprehensive assessment of the magnitude, distribution, and recoverability of various categories of geothermal resources in the United States is discussed. The first sections of this assessment include estimates of the total resource base, subdivided into categories of geothermal systems. The later sections consider the parts of the resource base that may be available for recovery and utilization, depending on various physical, economic, and technological constraints. A technological distinction is made between resource base and resources, in contrast to the distinctions among submarginal resources, paramarginal resources, and reserves, which are economic. (LBS)

3337 (CIRC—726, pp 5-57) **Hydrothermal convection systems.** Renner, J.L.; White, D.E.; Williams, D.L. 1975.

In Assessment of geothermal resources of the United States, 1975.

The fundamental and general characteristics of vapor-dominated and hot-water systems are described. The location, temperature data, and reservoir assumptions are tabulated for two-hundred ninety identified hydrothermal convective systems. (LBS)

3338 (CIRC—726, pp 58-83) **Igneous-related geothermal systems.** Smith, R.L.; Shaw, H.R. 1975.

In Assessment of geothermal resources of the United States, 1975.

Numerical estimates of magnitudes and heat contents of identified volcanic systems in the United States are tabulated. A partial list of known volcanic fields known or inferred to be less than 10,000 years old is also given. (LBS)

3339 (CIRC—726, pp 84-103) **Temperatures and heat contents based on conductive transport of heat.** Diment, W.H.; Urban, T.C.; Sass, J.H.; Marshall, B.V.; Munroe, R.J.; Lachenbruch, A.H. 1975.

In Assessment of geothermal resources of the United States, 1975.

The heat-flow provinces of the United States as they are presently known are described. Estimates are presented of temperatures to a depth of 10 km in these provinces and of the range of temperature that might be expected within each province. The physical data and assumptions that constrain these estimates are summarized. The temperature distributions are integrated with area and depth to give an estimate of 8.1×10^{24} cal. for the sensible heat stored in the Earth to a depth of 10 km. This quantity represents an upper limit to the thermal energy that can be extracted from the top 10 km of the solid earth in the United States. (LBS)

3340 (CIRC—726, pp 104-121) **Geothermal resources in hydrothermal convection systems and conduction-dominated areas.** Nathenson, M.; Muffler, L.J.P. 1975.

In Assessment of geothermal resources of the United States, 1975.

Estimates are reported of the parts of the resource base of heat in hydrothermal convection systems and conduction-dominated areas that can be considered as resources or reserves. These estimates involve analysis of physical recoverability, conversion or utilization efficiency, and economics. (LBS)

3341 (CIRC—726, pp 122-124) **Recoverability of geothermal energy directly from molten igneous systems.** Peck, D.L. 1975.

In Assessment of geothermal resources of the United States, 1975.

The critical problems involved in recovering energy directly from molten igneous systems are discussed in terms of the three major stages in developing the energy of such a body: (1) finding a magma body and determining its size, depth, composition, heat content, etc., by remote techniques; (2) drilling into the body and emplacing a heat-transfer device sufficiently strong and corrosion resistant to last an appreciable period; and (3) extracting energy from the body at a sufficient rate to amortize development and production costs. (LBS)

3342 (CIRC—726, pp 125-146) **Assessment of onshore geopressured-geothermal resources in the northern Gulf of Mexico basin.** Papadopulos, S.S.; Wallace, R.H. Jr.; Wesselman, J.B.; Taylor, R.E. 1975.

In Assessment of geothermal resources of the United States, 1975.

An assessment is made in a general way of the resource potential of geopressured geothermal reservoirs within the onshore part of Tertiary sediments under an area of more than 145,000 km² along the Texas and Louisiana gulf coast. The area was divided into subareas and the geopressured zone within each subarea was idealized as a conceptual reservoir. The areal extent of each

subarea, as determined by planimetric methods, the average depth to the top of geopressure, and the average pressure, temperature, and salinity conditions are tabulated. "Order-of-magnitude"-type assessments of the thermal energy, methane energy, and mechanical energy recoverable from the conceptual reservoirs are provided according to three assumed development plans. (LBS)

3343 (CIRC—726, pp 147-155) **Summary and conclusions.** White, D.E.; Williams, D.L. 1975.

In Assessment of geothermal resources of the United States, 1975.

Summaries are given of the geothermal resources of hydrothermal convection systems and of geopressured sedimentary environment assumed recoverable with present and near-current technology and without regard to cost. It is concluded that the identified high-temperature convection systems and the evaluated onshore parts of the gulf coast geopressured system are estimated to have a production potential of about 42,000 MW.century of recoverable electricity. (LBS)

OTHER

3344 (LA-UR—75-1590) **From rags to riches: an overview of solid waste management and energy recovery.** Miller, E.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 14 Apr 1975. Contract W-7405-eng-36. 18p. (CONF-750942—1). Dep. NTIS $4.00.

From Energy conservation symposium; Albuquerque, New Mexico, USA (17 Sep 1975).

An overview of recycling residential, industrial, and municipal wastes is presented and includes methods, systems, and market potential for the by-products. An economic analysis of resource recovery must be made to identify the capital investment, operating costs, and return on investment. Evaluations to date by EPA and others indicate that a minimum of 200-240 tons per day of refuse is required to justify a cost-effective energy recovery project. Over 40 communities are presently conducting feasibility studies. By 1980, 30 cities and counties plan to have 36 plants in operation processing 1,000 ton/day, a heat equivalency of 40,000 bbl/day oil equivalent. (One barrel of oil is equal to 5.8 million Btu.) The recovery efficiencies of inorganic material that can be recycled is between 67 to 75% for scrap aluminum, 90% for iron, and 70% for glass. It is concluded that if a maximum feasible level of resource recovery from residential and commercial waste were achieved in all major urban areas in the U.S., the equivalent would be the Nation's entire energy consumption for residential and commercial lighting, or more than half the direct oil imports from the Middle East in 1972, or almost one-third of the energy that will be delivered by the Alaskan pipeline. The recovery process also offers a reasonable alternative to the growing problems of landfill in municipalities. (MCW)

3345 (UCID—3724) **Wind energy for human needs.** Merriam, M.F. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1974. Contract W-7405-eng-48. 100p. Dep. NTIS $6.00.

A review of the history of wind utilization is presented. Wind machines that are in use or have been considered are categorized as small when the power output is up to 2 kW; medium, up to 100 kW; and large, when output is over 100 kW. The largest wind machine that ever operated was the 1250-kW Smith—Putnam wind turbine; the largest factory-produced machine today is a 6-kW model. A 100-kW test unit is being erected near Sandusky, Ohio by NASA to be operational in 1975. Environmental and engineering aspects, application areas, and geographical regions of greatest promise are discussed. To fully utilize the intermittent wind energy, an interruptible load, an energy storage system, or a standby source able to respond on demand is required. Examples of these alternatives are: interruptible load (pumping water for livestock or irrigation, driving refrigeration compressor for large-thermal-capacity cold-storage plant); energy-storage system of electrochemical storage batteries, flywheels, or pumping water for later generation of electric power through a hydraulic turbine; or a standby source of hydroelectric power dam, diesel generator, gas or steam turbine. Using wind-generated electricity to electrolyze hydrogen is interruptible load if the hydrogen is used for cooking fuel; it is an energy storage system if the hydrogen is stored to be reconverted to electricity with a fuel cell or an engine generator set. A 5-kW wind - hydro scheme is analyzed for Amarillo, Texas in Appendix A. It is concluded that the system is expensive and cumbersome, requires a large reservoir and a lot of equipment for providing only a small amount of firm power, but provides reliable electric power with zero fuel consumption and minimal maintenance. (53 references) (MCW)

ELECTRIC POWER

3346 (UCID—3734) **Disaggregating the electric utility sector in a 97-sector linear model of the U.S. economy.** Poppe, S.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Apr 1975. 20p. Dep. NTIS $4.50.

A model of fuel and energy use in the U.S. economy is being developed from an input - output (I/O) table for the economy published by the Bureau of the Census. One objective is the determination of the economic impact of constraints on fossil-fuel supplies. Substitution among energy-intensive technologies with various fuel requirements is one way the economy responds to such constraints. An essential feature of the I/O approach is a lack of substitution possibilities. This is because there is only one linear technology available to produce any commodity. It is therefore necessary to explicitly represent the several technological alternatives available in the production of a commodity in order to study the possibilities for substitution among inputs as input supplies vary. This takes the form of replacing a single productive activity (column) in the I/O table by the several possible activities (or columns) corresponding to various technologies. This note describes a technique for doing this in one energy-intensive sector of the U.S. economy, the generation of electric energy. A single aggregated activity is disaggregated to reflect options to generate electrical energy via nuclear steam, fossil steam (using various mixes of fossil fuel), and falling water, resulting in nine available technologies. ... Once the technological detail of the model has been enriched, plant capacity limitations and fuel availabilities must be developed. Disaggregation and capacity limitation transforms the I/O table into a linear programming model once an objective function (GNP) is introduced. (from Introduction)

3347 (UCRL—51890) **Price elasticity in electric-power demand forecasting.** Cooper, R.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Sep 1975. Contract W-7405-eng-48. 15p. Dep. NTIS $4.00.

Despite recent unprecedented increases in electricity prices, many private groups as well as some Federal agencies still project that growth of electric-power demand will continue in the future as it has in the past. These projections implicitly assume that the price elasticity of the demand for electric power is at or near zero. However, recent econometric studies of electric-power demand indicate that the price elasticity of demand is far from being zero and, assuming continued increases in electricity prices, will significantly reduce the future growth rate of electricity. This report provides a brief survey of price-elasticity studies of U.S. electric power demand and discusses some possible implications for long-range planning decisions in the electric utilities industry. (auth)

ELECTRIC POWER GENERATION

3348 (UCRL—76912) **Energy dynamics of an expanding power generating system.** Sauter, G.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Nov 1975. Contract W-7405-eng-48. 5p. (CONF-751116—3). Dep. NTIS $4.50.

From Nuclear science symposium; San Francisco, California, USA (17 Nov 1975).

A computer program has been developed to study the magnitude and time dependence of the net power and net energy generated by an expanding system of identical power plants. Application of the program to several expansion modes over a range of values for the rate of expansion, the net energy generated by an individual plant, and the construction time for each plant has led to some interesting results concerning the impact of the expanding system on the overall energy picture. In particular, during a rapid expansion phase, the system of power plants may be a better means of energy storage than of energy generation. (auth)

TRANSPORT AND STORAGE

3349 (BNL—20523) **Target capital costs for the implementation of fuel cells and electric storage devices within the national energy system.** Braun, C.; Cherniavsky, E.A.; Salzano, F.J. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 34p. (CONF-751032—1). Dep. NTIS $5.00.

From Fall meeting of the Electrochemical Society; Dallas, Texas, USA (5 Oct 1975).

The allowed capital cost for the introduction of fuel cells and electric storage devices into the year 1985 national energy system are examined, utilizing the Brookhaven Energy System Optimization Model (BESOM). The storage devices are characterized by their overall electric-to-electric conversion efficiencies and by

their expected lifetimes which are varied parametrically over the entire range of feasible efficiencies and lifetimes. Electric storage devices are considered as peaking plants, operating at load factors of 0.05, 0.10, and 0.20. The possible introduction of electric storage plants to intermediate load service at a load factor of 0.50 and to both intermediate and peaking load generation when operating on a weekly instead of a daily cycle, is also considered. The capital costs at which these devices become economically attractive are calculated using the marginal values obtained from the linear programming problem solution. The break-even capital costs (which include capitalized operation and maintenance expenditures) are computed as a function of the conversion efficiencies and expected lifetime for various residual and distillate fuel oil prices. (auth)

CONSUMPTION AND UTILIZATION

3350 (CONF-751120—1) **Policies to reduce transportation fuel use.** Hirst, E. (Oak Ridge National Lab., Tenn. (USA)). [nd]. 24p. Dep. NTIS $4.50.

From EPA symposium; Denver, Colorado, USA (3 Nov 1975).

This paper reviews historical trends in passenger traffic and energy use since 1950. Overall, transportation fuel use grew from 8.9 QBtu in 1950 to 18.3 QBtu in 1974 with an average annual growth rate of 3.0%. Energy use grew more rapidly than did traffic during this period because of shifts from energy-efficient to energy-intensive modes and increases in energy-intensiveness for most modes (due both to declining load factors and reduced vehicle fuel economy). A number of alternatives exist for reducing transportation fuel use. This paper discusses the energy savings possible due to expanded and improved urban mass-transit services, increases in new car fuel economy, increases in the price of gasoline, and increases in commute-auto occupancy (carpooling). Expanded mass transit is likely to save only small quantities of energy during the next five to ten years, primarily because of the very low fraction of urban passenger travel now carried by transit. Legislating increases in new-car fuel economy and/or higher gasoline prices can save substantial quantities of fuel both in the short and long run. Policies to induce higher auto occupancy during peak periods are unlikely to save much energy both because of their political infeasibility and individual reluctance to change habits. (auth)

3351 (ORO—4398-3, pp 10-18) **Energy of railroads and highways and other transportation modes.** Zucchetto, J.J. 1975.

In Energy models for environment, power, and society.

Total energy consumption of transportation systems includes direct fuel consumption, energy costs of capital, construction, maintenance, replacement, and labor; and natural energy costs that involve disruptions in the environment. A systems model for the railroad system is shown with considerations of labor, resources, money, fuel, and natural systems. Some numerical values are indicated for the railroad system of the U.S. as a whole, with the main emphasis on the hauling of freight. A comparison between railroads and automobiles for passenger transportation is shown schematically. The concept of energy quality for a system relates to the energy output for a given energy input. Data are tabulated for pipelines, railroads, trucks, airplanes, and waterways. Energy ratios that involve energy value of the goods shipped to the total energy in support of the transportation system are tabulated for pipelines, railroads, trucks, and airplanes. (MCW)

3352 (UCID—3731) **Program debugging and testing a linear programming analysis of U.S. production, employment, and energy use.** Merrill, D.; Lofting, E.; Quong, C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 26 Feb 1974. 12p. Dep. NTIS $4.50.

Preliminary work on a linear programming analysis of U.S. production, employment, and energy use is under way at LBL. A series of computer programs reads interindustry transactions data, employment data, and energy flow data in an input - output (I/O) format; performs necessary aggregations and calculates direct I/O coefficients; and provides appropriate input data to the linear programming package GUMPS. Several basic computer programs are now debugged and tested, and the flow of data from input tapes to final printed results is accomplished with a minimum of time-consuming hand operations. The format of the data cards and the structure of the component programs are flexible to permit easy later modification. For preliminary debugging and testing of the programs, 1963 national transactions data, employment data, and energy flow were used. The data aggregated into 12 broad sectors: agriculture, forestry, and fisheries; coal mining; crude petroleum and natural gas; other mining; construction; petroleum refining and related products; primary metals manufacturing; other manufacturing; electric utilities; gas utilities; transportation, communication, other utilities; and trade, finance, services, government. (auth)

ENERGY CONVERSION

MHD GENERATORS

DESIGN AND DEVELOPMENT

3353 (ERDA—65) **Amplified specifications for the final design of the US channel for the U-25.** Sheindlin, A.E. 1975. Translation of Russian report. 6p. Dep. NTIS $4.00.

This report is intended to serve as a supplement to the "Specifications for the Design of an MHD Generator Channel for the U-25 Facility," in accordance with the US-USSR cooperative program in MHD and contains all the additional data and clarifications given earlier to the US side, as the need arose, during the preliminary design stage, as well as certain additional data that appeared as a result of experiments run on the U-25. (auth)

3354 **Status of the two-phase liquid—metal MHD program at the Argonne National Laboratory.** Cutting, J.C.; Amend, W.E. (Argonne National Lab., IL). pp 1058-1063 of In 9th intersociety energy conversion engineering conference proceedings. San Francisco; American Society of Mechanical Engineers (1974).

From 9. intersociety energy conversion engineering conference; San Francisco, CA (26 Aug 1974).

Advanced power cycles utilizing two-phase liquid-metal MHD generators have been modeled mathematically and analyzed in depth at Argonne National Laboratory. The models developed in these studies, which have included all first-order irreversibilities, indicate the potential for two-phase liquid-metal MHD power cycles. Results are presented that indicate that overall thermal efficiencies in excess of 50 percent are possible with a maximum cycle temperature of 1600°F and efficiencies in excess of 55 percent are possible when the LMMHD system is used as a bottoming cycle in conjunction with a plasma MHD topping unit. The cycle studies indicate that the LMMHD cycle is potentially compatible with many of the advanced heat sources currently under development in the United States. These include the LMFBR, fluidized bed coal combustor, HTGCR and a fusion reactor. Of particular interest is the application of the liquid-metal MHD system as a topping cycle for a conventional steam plant employing a LMFBR. Preliminary studies indicate that the water-liquid metal interface can be eliminated and that cycle efficiencies in excess of 40 percent can be achieved. An Extensive Experimental program has been carried out at ANL in an effort to demonstrate the performance of the two-phase liquid-metal MHD generator. Results of these experiments, performed in an ambient temperature NaK-N_2 loop, indicate that the three major loss mechanisms in the LMMHD generator; end losses, internal current shunting, and slip losses, can be controlled to levels consistent with the achievement of a generator turbine efficiency in excess of 70 percent as required to make the aforementioned cycle performance possible. (auth)

PERFORMANCE AND TESTING

3355 (ERDA—66) **Influence of ash on the operation of an MHD generator channel in the U-02 facility.** (AN SSSR, Moscow. Inst. Vysokikh Temperatur). 1974. Translated from Russian. 20p. Dep. NTIS $4.00.

An effort was made to obtain experimental data with the U-02 facility on the operation of an MHD generator in the presence of ash in the combustion products. For this purpose, anthracite culm was induced into the combustion products of the U-02, to simulate the environment of an MHD generator working with coal. Ash with an average particle dimension of 3 microns was used in the experiment. The ash was induced into the combustion chamber by means of an installation consisting of a hopper for loading the ash, an ejector and a pneumatic line with a measuring device. The influence of the ash present in the combustion products on the insulation characteristics of the MHD generator assembly and on the operation of the electrodes was studied. Results are presented. (WHK)

DUCT ENGINEERING AND FLUID DYNAMICS

3356 (FE—1733-T-1) **Preliminary design of a magnetohydrodynamic (MHD) channel for the U.S.S.R. U-25 facility. Final report.** Brogan, T.R.; Aframe, A.M.; Hill, J. (MEPPSCO, Inc., Boston, Mass. (USA)). Nov 1974. 304p. Dep. NTIS $7.60.

This report portrays the results of the preliminary design effort for a magnetohydrodynamic (MHD) channel for the USSR U-25 facility. It also delineates the design and engineering effort required to make this channel compatible with the High Performance Demonstration Facility (HPDF) located at the Arnold Engineering Development Center, Arnold Air Force Station, Ten-

nessee. The channel is of a variable wall angle, single output, wndowframe design. This preliminary design provides a departure point from which both detail design and construction may proceed concurrently. A detailed program plan and schedule for the final design, construction and proof testing of the channel at the HPDF and U-25 facilities is included. (auth)

FUEL CELLS

DESIGN AND DEVELOPMENT

3357 (BNL—20504) **Role and allowed costs of fuel cells as electric generating devices.** Braun, C.; Cherniavsky, E.A.; Salzano, F.J. (Brookhaven National Lab., Upton, N.Y. (USA)). Sep 1975. 40p. Dep. NTIS $3.75.

The break-even capital costs for introducing fuel cells burning different fuels into the year 1985 national energy system are considered. Four types of electric generating systems are discussed: distillate oil and natural gas fuel cells, hydrogen electric storage system based on hydrogen produced from off-peak power, and fuel cell generators based on hydrogen produced from coal gasification. Each generating device is characterized by its fuel to electric conversion efficiency, by the utilization factor, and the useful lifetime. The expected lifetime is reflected in the value of the capital recovery factor utilized in the cost computations. The current series of computations assumes a 0.15 capital recovery factor, which is based on an assumed lifetime of 30 years and 14.76 percent amortization rate. (from Introduction)

ENERGY CONSERVATION, CONSUMPTION, AND UTILIZATION

BUILDINGS

RESIDENTIAL

3358 (ORNL-NSF-EP—85) **Room air-conditioner lifetime cost considerations: annual operating hours and efficiencies.** Pilati, D.A. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 29p. Dep. NTIS $4.00.

The annual hours of air-conditioning compressor operation are calculated for two types of use: (1) a house that is naturally ventilated to temperatures between 75 and 78°F when the outdoor temperature and wind speed will permit, and air conditioned at 78°F when required, and (2) a house that remains closed-up and is air conditioned at 78°F. For the 10 cities investigated, compressor savings from natural ventilation ranged from 12 percent in Phoenix to 73 percent in San Diego. These results are generalized to estimate the compressor-operating hours for any U. S. location. Potential purchasers of air conditioners can use this information to estimate their operating costs. The variation of an air conditioner's energy efficiency ratio (EER) with outdoor conditions is given. For units having continuously operating fans, the EER decreases dramatically at milder outdoor temperatures. For example, a high efficiency model is shown to suffer a 40 percent decrease in EER when outdoor temperature is 75°F compared to that when temperatures are in the low 90's. Seasonal EERs are given for four units in 10 cities. Units with continuously operating circulating fans have EERs that average 8.5 percent below the nameplate value. For the cities and four units investigated, the use of an automatic circulating fan that only operates during the cooling cycle would increase the EER from 12 to 34 percent over an identical unit using a continuous fan. If existing room air conditioners were converted to automatic fan operation, about 4.4 billion kilowatt hours would be saved in 1975. (auth)

3359 (ORNL-NSF-EP—88) **Heat balance and efficiency measurements central, forced-air, residential gas furnaces.** Hise, E.C.; Holman, A.S. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 65p. Dep. NTIS $5.45.

Residential central gas furnaces of the atmospheric combustion and sealed combustion types were tested in the laboratory and in residences. Complete heat balances were taken at steady-state operation, cyclic operation, and off-design conditions, and the instantaneous efficiencies were determined. The seasonal fuel utilization efficiencies were synthesized for the two types of furnaces and for a range of adjustments in four climates. Recommendations are offered for a high-efficiency furnace design and installation standards which will reduce fuel consumption by one-third. (auth)

ADVANCED AUTOMOTIVE PROPULSION SYSTEMS

ELECTRIC-POWERED SYSTEMS

3360 (UCID—3771) **Backup system to BART automatic train control system leading to transbay crossing. Progress report, March 1974.** Scalise, D.T.; Evans, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Mar 1974. 26p. Dep. NTIS $5.00.

A program was begun to: (1) investigate problems of the Bay Area Rapid Transit District (BART) Automatic Train Control (ATC) system; (2) evaluate tentative corrective strategies; and (3) provide technical evaluations of other system matters. BART ATC problem areas include train detection and collision avoidance resulting from lost occupancy indications. Corrective measures, referred to as the Backup System, were developed to add additional memory capability to the ATC for the last detected position of all trains. Additional efforts are being made to measure the performance of the ATC and to evaluate the logic equations and the traffic-simulation programs. (PMA)

3361 (UCID—3772) **BART train control subsystems: CABS and SOR for the transbay crossing.** Scalise, D.T.; Evans, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 20 May 1974. 18p. Dep. NTIS $4.50.

Preliminary progress is reported on two control subsystems of the Bay Area Rapid Transit (BART): (1) the Computer Augmented Backup System (CABS); and (2) the Sequential Occupancy Release System (SOR). CABS is an interim system for train separation to be used until the SOR Backup System is activated. CABS was analyzed, failure modes of both software and hardware were studied, and preliminary suggestions of corrective measures are made. (PMA)

3362 (UCID—3773) **BART train control subsystem: summary and status of recommendations for CABS and the transbay crossing.** Scalise, D.T.; Evans, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 15 Jul 1974. 19p. Dep. NTIS $4.50.

Progress is reported on the effort to evaluate the Computer Augmented Backup System (CABS) proposed for the Bay Area Rapid Transit (BART) transbay service. A summary of recommendations resulting from a detailed study, the status of these recommendations, and conclusions with respect to the CABS system development are presented. Findings and recommendations on the CABS hardware and software already adopted and those intended for future action are reviewed. (PMA)

3363 (UCID—3774) **Evaluation of BART, August 3 test for transbay service.** Scalise, D.T.; Evans, D.M.; Wiley, K.G.; Louis, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 23 Aug 1974. 24p. Dep. NTIS $4.50.

A full-scale performance test is reported of the Computer Augmented Backup System (CABS) for the Bay Area Rapid Transit (BART). The test, involving 36 trains, was performed to analyze the original computer augmented train control system as it would operate in a failure situation. Recommendations for improved automatic safeguards were made to achieve two objectives: (1) to improve the CABS ability to automatically maintain a one-station separation between trains; and (2) to have the protection revert to that provided by the basic Automatic Train Control system for the worst case that could arise in the computer augmented system. (PMA)

3364 (UCID—3775) **LBL role and recommendations with respect to PUC hearings on BART safety appliances and procedures.** Scalise, D.T.; Evans, D.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 18 Feb 1975. 23p. Dep. NTIS $4.50.

Methods are discussed for increasing the level of safety of the Bay Area Rapid Transit (BART) by reducing the susceptibility of the BART system to human error. Recent incidents clearly demonstrated the vulnerability of operations carried on in the manual mode. The recommendations emphasize that: (1) the potential of the automatic systems be more fully used, particularly with respect to maintenance vehicle detection; (2) the safety regulations for manual operations be analyzed thoroughly; and (3) an intense task force be assigned to address high-priority problems. (PMA)

3365 (UCID—3776) **Recommended prerequisites for replacing CABS with SOR in the BART train control system.** Scalise, D.T.; Evans, D.M.; Elischer, V.F.; Louis, R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 7 Jul 1975. 12p. Dep. NTIS $4.50.

An evaluation is given of the prerequisites for the replacement of the train control system for the Bay Area Rapid Transit (BART). The Sequential Occupancy Release System (SOR) has several potential advantages for long-range improvement over the currently used Computer Augmented Backup System (CABS): (1) better resolution capability--train occupancy information for more than 1500 individual blocks can be displayed; and (2) better maintenance capability--an automatic problem reporting system is compatible with the SOR system. SOR will, however, have some shortcomings with respect to certain operational problems, failsafe reliability, and failure detection. It is concluded that SOR, used as a backup system, can provide a level of safety comparable to that provided by CABS. (PMA)

ALTERNATIVE FUELS

3366 (EPA—460/3-74-012a) **Alternative fuels for automotive transportation: a feasibility study. Volume I. Executive summary.** Pangborn, J.; Gillis, J. (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1974. Contract 68-01-2111. 33p. Dep. NTIS $4.75.

The objectives of this study were to identify and characterize potentially feasible alternative fuels, to assess their economic and technical practicality and to recommend the most promising fuels for three specific time frames. A model for energy supply and demand by market sectors was devised, and cost estimates were made. It was concluded that alternative automotive fuels from domestic sources can alleviate petroleum imports. Coal, oil shale, and fissionable nuclear fuels are adequate resources, while the preferred fuels are gasoline and hydrocarbon distillates, methanol, and hydrogen. An executive summary of this study is presented. (PMA)

3367 (EPA—460/3-74-012b) **Alternative fuels for automotive transportation: a feasibility study. Volume II. Technical section.** Pangborn, J.; Gillis, J. (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1974. Contract 68-01-2111. 283p. Dep. NTIS $15.00.

The technical details of a study to find suitable non-petroleum-based fuels which are available on the long-term from domestic sources are presented. Factors considered include: (1) energy demand and supply; (2) fuel availability; (3) fuel synthesis technology; and (4) the physical, chemical, and combustion properties of the fuels. (PMA)

3368 (EPA—460/3-74-012c) **Alternative fuels for automotive transportation: a feasibility study. Volume III. Appendices.** Pangborn, J.; Gillis, J. (Institute of Gas Technology, Chicago, Ill. (USA)). Jul 1974. Contract 68-01-2111. 114p. Dep. NTIS $8.75.

Various data collected in a study of domestic, non-petroleum based automotive fuels are presented in two appendices: (1) properties of potential alternative fuels for automotive transportation; and (2) detailed process descriptions and economics for candidate fuels from coal and oil shale. The combustion characteristics, the overall energy balance and efficiency, the pollution problems, and an economic analysis are presented for each of the candidate fuels from coal and oil shale. (PMA)

3369 (UCRL—52000-75-9, pp 13-16) **Adapting the automobile to methanol: one practical approach.** Sep 1975.

In Lawrence Livermore Laboratory energy and technology review.

To adapt present automobiles to alternate fuels like methanol, we envision a closed-loop, computer-controlled, fuel and ignition system used in conjunction with a novel adaptive fuel tank. The fuel tank, designed for electronic fuel injection, will enable an automobile to run on either gasoline or methanol. Thus alternate fuels could be introduced regionally without affecting the ability of cars to travel freely. The computer control system with closed-loop monitoring of engine operation will optimize the fuel and ignition systems, improving efficiency and reducing emissions. Together, the adaptive fuel tank and computer control will allow an evolutionary change in engine designs for new fuels as well as the evolutionary introduction of a new fuel manufacturing and distribution system. (auth)

3370 (UCRL-Trans—10926) **Methanol, the future in motorized transportation.** Lachmirowicz, M. Translated from *Przem. Chem.*; **54**: No. 3, 160-164(1975). 16p. Dep. NTIS $4.50.

The continuous development of motorized transportation demands the development of sources of motor fuels to be used in place of those presently produced from crude oil. Such a replacement fuel may be methanol, which, in many aspects, is better than the currently used fuels. The use of methanol as a motor fuel is discussed with respect to: (1) replacing gasoline; (2) faults and disadvantages; (3) use in high compression engines; (4) current production techniques; (5) raw material bases; (6) price forecasting relative to other fuels; and (7) the specific situation of Poland as a producer of methanol. (PMA)

MATERIALS

3371 (JUL—1195) **Calculations of shape and stability of menisci in Czochralski growth with tables to determine meniscus heights, maximum heights, and capillary constants.** Uelhoff, W.; Mika, K. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Festkoerperforschung). May 1975. 138p. Dep. NTIS (US Sales Only) $7.00.

The shape and stability of menisci occurring during Czochralski growth have been studied by means of numerical methods for the case of the free surface. The existence of minimal joining angles is shown, beyond which the growing crystal will separate from the melt. The dependence of the interface height on the joining angle for different crystal diameters was calculated. The maximum stable heights and the corresponding joining angles were determined as a function of crystal diameter. A method for measuring the capillary constant of the melt during Czochralski growth is proposed. Our results are compared with known analytical approximations. Limitations of the applications caused by a finite crucible radius or low g values are pointed out. For practical use the following functions have been tabulated: (a) meniscus height in dependence on joining angle and crystal radius, (b) the radius-height-ratio in dependence on radius and angle for the calculation of the capillary constant, (c) the maximum stable height and the corresponding growth angle as a function of crystal radius. (auth)

3372 (LBL—3563) **Thermodynamic aspects of solid state sintering.** Pask, J.A.; Hoge, C.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1975. Contract W-7405-ENG-48. 11p. (CONF-750501—2). Dep. NTIS $4.50.

From 4. Notre Dame conference on sintering; Notre Dame, Indiana, USA (25 May 1975).

A phenomenological analysis is given of the densification processes, driving force for mass transport, and conditions under which grain boundary movement and grain growth occur. Two- and many-sphere models are developed. Desirable conditions for sintering are determined to be: uniform size particles, highest green density, low γ/sub ss/γ/sub sv/, minimum anisotropy of interfacial energies, and small experimental dihedral angle. (DLC)

3373 **Exactly solvable model for tricritical phenomena.** Emery, V.J. (Brookhaven National Lab., Upton, NY). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 294-295(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

An n-component continuous spin model with a tricritical point is solved exactly in the limit n Σ infinity, and its properties are described. (auth)

3374 **Spectral weight of low-lying excitations in the one-dimensional spin 1/2 Heisenberg antiferromagnet.** Bonner, J.C. (Univ. of Utah, Salt Lake City); Sutherland, B.; Richards, P.M. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 335-337(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Numerical calculations on a spin 1/2 one-dimensional (1D) Heisenberg antiferromagnet for N = 8 spins were examined both for the states and their spectral weights. This work is of interest because of the recent neutron scattering experiments in $CuCl_2.2NC_5D_5$ which show the spectral weight to be concentrated at the des Cloizeaux and Pearson (dCP) spin wave frequencies. The states form a two-parameter continuum between the dCP value $E_1(k) = \pi/J|\sin k/$ and the upper limit $E_2(k) = 2\pi/J|\sin(k/2)|$. Though most of the spectral weight is at the dCP frequency for N = 8, about 10 percent of it is found near E_2 for $k = \pi$. There is no numerical evidence for the existence of singlet bound states as predicted by Ovchinnikov. (auth)

3375 **Insulating states and metal-nonmetal transition in the Hubbard model.** Arai, T. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 341-342(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

If a band is narrow and is not nearly empty or nearly full, the Hubbard lattice is an insulator. A nearly half-filled lattice is a Hubbard-type insulator with a gap but if the number of electrons decreases or increases beyond a certain limit, the lattice becomes a

"gapless" insulator. As the bandwidth increases, these insulating states will turn metallic. The mechanism involved in the transition is presented. (auth)

3376 Comparison of the magnetic properties of the Hubbard hamiltonian in the weak correlation limit to the HFA. Bartel, L.C. (Sandia Labs., Albuquerque, NM); Jarrett, H.S. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 343-344(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Resonance broadening is included along with spin-disorder scattering to study the magnetic properties of the Hubbard Hamiltonian in the weak correlation limit. The calculated susceptibility is compared to the exchange enhanced Hartree--Fock approximation (HFA) susceptibility, and limits are set on the applicability of the HFA. For a semicircular density of states, HFA appears to be applicable for $I/\Delta < 0.5$ and a half-filled band, but for low electron (or hole) densities the range of applicability in I/Δ decreases. (auth)

3377 Theory of spin-lattice relaxation for paramagnetic ions. Wilson, R.S.; Fedro, A.J.; Knauss, D.C. (Northern Illinois Univ., DeKalb). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 524-525(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Relaxation of a two spin-state paramagnetic ion embedded in an ionic lattice is considered. The decay mechanism is assumed to be due to the vibrational modulation of the crystalline electric field which acts on the orbital motion of the paramagnetic electrons. The relaxation rate first expressed in terms of a time-correlation function involving an effective interaction which is the matrix element of the interaction between the two spin states. The calculation of this correlation function is based on a projection operator method similar in spirit to the recent treatment of the Hubbard model. The essential result is an exact expression for the relaxation time in terms of the Fourier transform of another correlation function involving only the lattice variables, which do the coupling, thermally averaged over the uncoupled lattice in equilibrium. (auth)

3378 Dynamics and statistical mechanics of a one-dimensional model hamiltonian for structural phase transitions. Krumhansl, J.A.; Schrieffer, J.R. (Univ. of Pennsylvania, Philadelphia). *Phys. Rev., B;* **11**: No. 9, 3535-3545(1 May 1975).

Thermodynamic and some dynamic properties of a one-dimensional-model system were studied whose displacement field Hamiltonian is strongly anharmonic and is representative of those used to study displacive phase transitions by studying the classical equations of motion. Important solutions (domain walls) were found which cannot be represented effectively by the usual phonon perturbation expansions. The thermodynamic properties of this system can be calculated exactly by functional integral methods. No Hartree or decoupling approximations are made nor is a temperature dependence of the Hamiltonian introduced artificially. At low temperature, the thermodynamic behavior agrees with that found from a phenomenological model in which both phonons and domain walls are included as elementary excitations. It is then shown that equal-time correlation functions calculated by both functional-integral and phenomenological methods agree, and that the dynamic correlation functions (calculated only phenomenologically) exhibit a spectrum with both phonon peaks and a central peak due to domain-wall motion. (auth)

3379 Theory of the temperature dependence of second-order elastic constants in cubic materials. Garber, J.A.; Granato, A.V. (Univ. of Illinois, Urbana). *Phys. Rev. Lett.;* **11**: No. 10, 3990-3997(15 May 1975).

The temperature dependence of the second-order elastic constants of cubic crystalline materials is derived on the basis of a quasiharmonic-anisotropic-continuum model. The strain dependence of the oscillation frequencies is assumed to be independent of wavelength. Results are expressed in terms of the properties of the static lattice on the assumption that higher-than-first-order effects in the (vibrational) strain for the actual lattice can be neglected. It is found for the present model that the temperature-dependent part of the adiabatic second-order elastic constants is not proportional to the vibrational energy. Mathematical expressions in terms of the second-, third-, and fourth-order elastic constants are given for three temperature regions: high temperatures, where the second-order elastic constants change linearly with temperature;for low temperatures, where they change as the fourth power of the temperature; and for the difference between the actual values at 0°K and the values extrapolated back to 0°K from the high-temperature linear region, this difference being due to the effect of zero-point oscillations. The theory should be most accurate for the low-temperature (fourth-power) region, mainly because the assumption regarding wavelength independence is not required, as only long-wavelength modes are effective in this region. (auth)

3380 Stochastic theory of spin-phonon relaxation. Pirc, R.; Krumhansl, J.A. (Cornell Univ., Ithaca, NY). *Phys. Rev., B;* **11**: No. 11, 4470-4482(1 Jun 1975).

Spin-phonon relaxation is interpreted as a quantum stochastic process. Time-dependent magnetization correlation functions are written in general exponential form, and the phase-modulation terms occurring in them are evaluated approximately to second order with respect to the coupling parameter. The spin-phonon interaction is described by the isotropic model of Huber and Van Vleck. A physical parameter corresponding to an effective Larmor precession frequency is introduced and determined from the zero-frequency longitudinal susceptibility, which is made consistent with the thermodynamic derivative of the magnetization. Longitudinal and transverse dynamic susceptibilities are calculated for all frequencies. At low frequencies, they agree with the usual Lorentzian model as expected from the asymptotic exponential decay of the correlation functions. The high-frequency spectra from the Lorentzian form and contain information on the short-time history of spin-phonon collisions. (auth)

3381 Classical one-dimensional Heisenberg magnet in an applied field. Blume, M. (Brookhaven National Lab., Upton, NY); Heller, P.; Lurie, N.A. *Phys. Rev., B;* **11**: No. 11, 4483-4497(1 Jun 1975).

Theoretical results are presented for the thermodynamic properties and time-independent spin-spin correlation functions for the classical Heisenberg magnetic chain in an applied magnetic field. The calculations are performed by numerical solution of the transfer-matrix integral equation. In addition, approximate variational procedures and low-temperature expansions yield some analytic results. The procedures used are applicable to any near-neighbor interaction for classical spins in a linear chain. The most unusual behavior found is for antiferromagnetic coupling, where the specific heat shows oscillations as a function of field, and the longitudinal uniform susceptibility and the transverse staggered susceptibility increase with field for low fields. (auth)

3382 Two point correlation function for general fields and temperatures in the critical region. Combescot, M.; Droz, M.; Kosterlitz, J.M. (Cornell Univ., Ithaca, NY). *Phys. Rev., B;* **11**: No. 11, 4661-4673(1 Jun 1975).

A calculation, to order $\epsilon^3(\epsilon = 4 - d)$, of the two-point-correlation function of an Ising-like system in the whole critical region, is presented. The scaling function is shown to be a cut-off-independent function of two variables which is universal in the context of a sharp cut off. Explicit asymptotic expansions in the large and small momentum (relative to the inverse correlation length) are given. Particular attention is paid to the corrections from the Ornstein--Zernike theory. These corrections are two orders of magnitude larger below T/sub c/ than above. Numerical comparison with series-expansion results agree surprisingly well. A powerful technique of evaluating diagrams using the Fourier tranform of the propagator is also presented. (auth)

METALS AND ALLOYS

3383 (CALT—822-65) **Radial distribution function of amorphous iron—phosphorous alloys.** Logan, J. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Oct 1974. Contract AT(04-3)-822. 20p. Dep. NTIS $4.00.

The density and radial distribution function of amorphous iron-phosphorous were measured at four different compositions ranging from 14.5 to 21.6 at. percent phosphorous. These alloys were produced by electrodeposition and the composition dependence of the density and radial distribution function are quite similar to other electrodeposited glasses. (auth)

3384 (ORNL-TM—5027) **Steam Generator Materials Technology Program quarterly progress report for period ending June 30, 1975.** Patriarca, P. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 292p. AT.

Results of research are reported in programs on steam generator materials for the CRBR plant, advanced ferritic alloys for LMFBR steam generators, alloy 800 development for LMFBR steam generators, tube sheet forging, and development of alternate structural materials for LMFBR type reactors. (JRD)

3385 (RDT-M—5-8T(10-75)) **Nickel—molybdenum—chromium alloy sheet and plate (ASME SB-434 with additional requirements), October 1975.** (Energy Research and Development Ad-

ministration, Washington, D.C. (USA). Div. of Reactor Research and Development). 17 Oct 1975. 9p. RSO.

This standard covers Ni—Mo—Cr alloy sheet and plate for nuclear and associated applications. Heat treatment, testing, examination, etc. are covered. (DLC)

3386 (UCRL—13661) **Origin of burst-type acoustic emission in unflawed 7075-T6 aluminum.** Bianchetti, R.; Hamstad, M.A.; Mukerjee, A.K. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Aug 1975. 20p. Dep. NTIS $4.50.

Tensile tests were performed to study the acoustic emission (AE) from 7075-T6 aluminum plate made by five manufacturers. Specimens from one particular plate showed a large burst-type emission superimposed upon the continuous emission. Metallographic and fracture surface studies were conducted in order to identify the source of the burst-type emission. It was concluded that the burst-type emission resulted from the brittle fracture of large (20-60 μm) primary inclusions in the microstructure. Results show the usefulness of incorporating AE measurement during manufacturing processes for such aluminum alloys for quality and process control. (auth)

PREPARATION AND FABRICATION

3387 (UCRL—77295) **Adiabatic surface thermometer for improved production braze quality.** Dittbenner, G.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 27 Aug 1975. 13p. (CONF-751012—8). Dep. NTIS $4.00.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

An adiabatic surface thermometer was developed to control automatically the critical temperature-time cycle of a production vacuum-brazing process. Investigations revealed that optimum braze-joint strength required precise control of the brazing temperature. Spot-welded thermocouples could not be used because the spot welds cause surface damage. This thermometer touches the surface and uses a differential thermocouple and heater to measure surface temperature without heat flow, thereby eliminating large errors caused by conduction losses common to conventional spring-loaded thermocouples. Temperatures in air or vacuum are measured to 800°C with errors less than 5°C. This thermometer has minimized the rejection of production parts, resulting in a cost saving to the U. S. Energy Research and Development Administration. (auth)

3388 (Y-OA—1545) **Influence of pressure variation on the penetration of electron beam welds.** Brandon, G.W. (Oak Ridge Y-12 Plant, Tenn. (USA)). 16 Jun 1975. Contract W-7405-eng-26. 19p. (CONF-751012—1). Dep. NTIS $4.00.

From SME;ERDA welding and joining workshop; Chicago, Illinois, USA (28 Oct 1975).

Pressure variations typically encountered during vacuum electron beam welding can influence the focus of the electron beam, resulting in significant variations in weld depth and width. This influence is especially noticeable in low-energy, partial-penetration welds. The pressure-focus interaction is discussed and samples of pressure-affected welds are described. (auth)

3389 **Compaction mechanics of submicron palladium power.** German, R.M. (Sandia Labs., Livermore, CA). *Int. J. Powder Metall. Powder Technol.*; **11**: No. 3, 169-176(Jul 1975).

Measurements of density, surface area, and pore size distribution, as well as electron microscopy, are used to map the consolidation process associated with cold pressing ultrafine electrolytic palladium powder. It is determined that plastic deformation is the predominant mechanism of consolidation, with particle rearrangement, fracturing, and bending processes being important to the initial densification. It is concluded that the initial stage of consolidation has the most detrimental effect on the catalytic and hydride properties of the powder. (auth)

STRUCTURE AND PHASE STUDIES

3390 (CONF-750949—6) **Characterization of reordered (001) Au surfaces by the combined techniques of positive ion channeling spectroscopy (PICS), LEED-AES, and computer simulation.** Appleton, B.R.; Zehner, D.M.; Noggle, T.S.; Miller, J.W.; Schow, O.E. III; Jenkins, L.H.; Barrett, J.H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. 18p. Dep. NTIS $4.50.

From International conference on ion beam surface layer analysis; Karlsruhe, F.R. Germany (15 Sep 1975).

The applicability of positive ion channeling techniques for studying the structure of single crystal surfaces was investigated. Characterization of the (001) surface of epitaxially grown Au single crystals by LEED and AES showed that when the (001) surface was sputter-cleaned and annealed in ultra high vacuum, the normal (lxl) symmetry of the (001) surface reordered into a structure which gave a complex (5 x 20) LEED pattern as previously reported. The yield and energy distributions of 1-MeV He ions scattered from the Au surfaces were used to determine the effective number of monolayers contributing to the normal and reordered surfaces. Computer simulation calculations were used to correlate the ion scattering results with model constructions for the normal and reordered surfaces. The combined techniques of PICS, LEED-AES, and computer simulation enabled the nature of the restructed surface to be characterized as one monolayer of hexagonal symmetry superimposed on the (001) substrate. (auth)

3391 (LBL—3586) **Optical absorption study of phase equilibria in the Ga—As—Zn and Ga—As—Cd systems with application to design of diffusion processes.** Styer, S.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1975. Contract W-7405-ENG-48. 109p. Dep. NTIS $8.50.

Thesis.

Partial pressures of zinc, cadmium, and arsenic in equilibrium with GaAs and other condensed phases were studied in the Ga—As—Zn and Ga—As—Cd systems under conditions feasible for vapor phase diffusion of zinc or cadmium into solid GaAs. The temperature range of the measurements was from 500 to 900°C with emphasis at 700°C. The method employed was ultraviolet absorption spectroscopy. At 700°C, the vapor-solid distribution coefficients for zinc and cadmium were determined as a function of arsenic pressure: ln k/sub Zn//sup v/ = 7.4952 + ln p/sub As_4//sup 1/4/ and ln k/sub Cd//sup v/ = 0.2895 + ln p/sub As_4//sup 1/4/. Design parameters for closed system diffusion processes were then derived using the partial vapor pressure data to match the requirements for diffusion. (JRD)

3392 (LBL—3962) **Electronic structure of molecules, solids, and solid surfaces.** Chelikowsky, J.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 313p. Dep. NTIS $10.75.

Thesis.

A detailed study is undertaken to investigate the electronic structure of eleven diamond and zincblende semiconductors: Si, Ge, ZnSe, α-Sn, InSb , CdTe, GaP, GaSb, InP, and InAs. By means of an empirical non-local pseudopotential scheme the optical spectrum, electronic density of states, and valence charge density is calculated for each compound. The theoretically required parameters are determined by comparisons with optical and photoemission experimental measurements. In particular, the effect of a non-local potential on the electronic structure of each compound is investigated. It is found that the local pseudopotential approach can yield incorrect band topologies, optical gaps, charge densities, and valence band widths. All of these defects can be corrected by the addition of a non-local term to the pseudopotential. In addition, to the calculations performed on these bulk materials, a method for calculating the electronic structure of non periodic systems is developed. This very powerful technique allows the direct application of the pseudopotential method to such systems as solid surfaces, localized impurity and vacancy states, atomic and molecular states, finite chains or layers, adsorbates, and interfaces between solids. Here the method is applied to molecules and surfaces. Specifically the molecular ground state energy levels and orbitals are calculated for diatomic silicon. With respect to surfaces, the technique is used to calculate the electronic structure of semiconductor and metal surfaces. The Si(111) surface is studied in detail. Calculations are performed using ideal, relaxed, and reconstructed surface models; the results are compared with experiment. The (110) surfaces of GaAs and ZnSe are also investigated. As an example of a metal surface the (111) surface of Al is considered. (auth)

3393 **MAGNETIC SMALL ANGLE SCATTERING OF SUBTHERMAL NEUTRONS ON INNER STRESS FIELDS IN TENSILE-STRAINED, CORNER-ORIENTATED NICKEL MONOCRYSTALS.** Vorbrugg, W. Brunswick; German, Federal Republic of (F.R. Germany); Technische Univ. (1973). 107p. (In German). INIS.

Thesis.

The anisotropic scattering distributions occurring on strongly distorted, corner-orientated nickel monocrystals, can be quantitatively interpreted using model calculations carried out in close accordance with electron microscopic results on the construction of the dislocation structure. Investigations on three-numbered samples, where the scattering maxima always occur in the direction of the glide plane normals perpendicular to the beam, showed that by considering the symmetry of the dislocation network, the photometric measurements cannot be explained by incoherent superposition of the contributions of single dislocations. Rather this explanation is only valid if the coherent scattering on extended stress regions stretching along the glide planes is considered as the basic scattering mechanism, the measurements of which can be determined by adapting to the experimental results. (GE)

3394 Thermodynamics of formation of Th—Cu alloys. Bailey, D.M.; Smith, J.F. (Ames Lab., IA). pp 355-365 of In Thermodynamics of nuclear materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.2); CONF-741030—P2.

Electromotive force cells have been used to determine the Gibbs free energies, enthalpies, and entropies of formation for $ThCu_6$, $ThCu_{3-\delta}$, $ThCu_2$, and Th_2Cu over the temperature range 729 to 1219°K. Solid CaF_2 was used as the electrolyte. Comparison of the present measurements with earlier measurements on the most copper-rich phase shows that the free energies are reproducible by this technique to approximately 4 percent. The magnitudes of the entropies of formation were all measured as less than 1 cal/g-atom.°K and are therefore physically reasonable. The values for the entropies of formation of $ThCu_6$ and $ThCu_{3-\delta}$ were found to be positive, that of $ThCu_2$ to be essentially zero, and that of Th_2Cu to be negative. Comparison with data from other thorium systems shows that positive entropies of formation are atypical for binary intermetallic phases of thorium. The free energies of formation of the Th—Cu phases were found to be roughly one-half as negative as values reported for Zr—Cu phases at comparable temperatures and stoichiometries. (auth)

3395 Pressure dependence of the magnetic ordering temperatures in Cr—Fe alloys. Edwards, L.R.; Fritz, I.J. (Sandia Labs., Albuquerque, NM). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 414-415(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The pressure dependences of the magnetic transition temperatures of Cr--2.5 and 2.8 at. percent Fe single crystal alloys were determined by electrical resistance and ultrasonic measurements. Results show that the 1 bar triple point (paramagnetic, incommensurate antiferromagnetic(I), and commensurate antiferromagnetic (c)) in the temperature concentration plane occurs at a concentration of ~ 2.5 at. percent Fe in contrast to the previously published value of 4 at. percent Fe. The high pressure data showed an abrupt change in the pressure dependence of the I--C transition at 3.3 kbar, from which it is speculated that an additional magnetic phase exists. (auth)

3396 Soft phonon mode at the martensitic phase transformation of $AuCuZn_2$. Mori, M. (Osaka Univ., Toyonaka, Japan); Yamada, Y.; Shirane, G. *Solid State Commun.*; **17**: No. 2, 127-130(1975).

The lattice dynamical property of $AuCuZn_2$ was investigated by means of inelastic neutron scattering technique in connection with its martensitic phase transformation. The temperature-dependent soft phonon was observed around q = 2/3[110] of TA_2 phonon branch. A premartensitic metastable phase was also found, in which new satellite reflections at (H plus or minus 2/3, K plus or minus 2/3, 0) were observed around fundamental reflections with H + K = 4n. The atomic displacements of the soft phonon mode correspond to the atomic arrangement of the premartensitic phase. (auth)

3397 Elastic solute-dislocation interaction in an anisotropic hcp crystal. Syn, C.K.; Ahmadieh, A.; Morris, J.W. Jr. (Univ. of California, Berkeley). *Philos. Mag.*; **31**: No. 4, 883-890(Apr 1975).

The interaction due to the size misfit between a substitutional solute atom and an edge dislocation is treated, employing anisotropic linear elasticity. The interaction energy contours and force—displacement relation for rigid glide of the dislocation are computed for silver and cadmium solute atoms in a zinc matrix and compared with those obtained by the isotropic treatment. The results for cadmium are rather similar to those of the isotropic computation. However, for silver there are large differences in the shapes and magnitudes of the interaction energy and force relation between the isotropic and anisotropic treatments. (auth)

3398 Possibility of observing self-interstitials in Cu and Al by neutron scattering. Wood, R.F.; Mostoller, M. (Oak Ridge National Lab., TN). *Phys. Rev. Lett.*; **35**: No. 1, 45-48(7 Jul 1975).

The librational modes of the (100)-split interstitial in fcc metals can undergo resonant hybridization with the phonons of the perfect crystal. As in the analogous case of $KCl:CN^-$, this hybridization leads to effects which can be observed by inelastic neutron scattering at concentrations orders of magnitude smaller than those required for the observation of effects introduced by simple substitutional impurities. (auth)

3399 Wave propagation in a condensed medium with N transforming phases: application to solid-I—solid-II-liquid bismuth. Hayes, D.B. (Sandia Labs., Albuquerque, NM). *J. Appl. Phys.*; **46**: No. 8, 3438-3443(Aug 1975).

Constitutive assumptions of local thermal and pressure equilibrium in a mixture of N transforming phases allow construction of a constitutive equation of a generalized Maxwellian form suitable for studying the kinetics of phase transformations induced by shock-wave loading. This equation relates the pressure rate to the strain rate and the phase change rate, the latter being expressed as the time derivative of a vector which has components equal to the mass fractions of the constituent phases. A separate kinetic equation is required for evolution of this composition vector. Coefficients appearing in the constitutive equation depend only on properties that the mixture displays with a frozen composition which in turn depend directly on properties of the pure-phase components of the mixture. The constitutive equation is applied to solid-I—solid-II—liquid bismuth (N = 3). When wave propagation calculations on bismuth are compared with previous theory and experiments, a lower bound on the melting rate of 4 μsec^{-1} is found. (auth)

3400 Anomalous inelastic neutron scattering in bcc Zr-Nb alloys. Axe, J.D.; Keating, D.T.; Moss, S.C. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev. Lett.*; **35**: No. 8, 530-533(25 Aug 1975).

Inelastic neutron scattering from bcc $Zr_{0.92}Nb_{0.08}$ at 965degreeC reveals features in the inelastic response which lack the average cubic symmetry of the lattice. This can be understood as arising from phonon modulation of quasistatic short-range order representing fluctuations into an incipient "ω" phase.

3401 Surface structure and stability of a tin-covered tungsten tip as observed in a field ion microscope. Nishikawa, O.; Saadat, R. (Pennsylvania Stae Univ., University Park). *J. Appl. Phys.*; **46**: No. 9, 4064-4068(Sep 1975).

The deposition of tin on a tungsten emitter tip and subsequent heating above 700°C results in a drastic change of the equilibrium shape of the emitter at an elevated temperature and the formation of a surface layer with unusual structure. The new surface layer requires a significantly higher external electric field to cause the migration of surface atoms than a bare tungsten surface layer. A tentative explanation is the formation of a closely packed two-dimensional alloy of transition and nontransition metals. (auth)

3402 Discontinuous coarsening of spinodally decomposed Cu—Ni—Fe alloys. Gronsky, R.; Thomas, G. (Univ. of California, Berkeley). *Acta Metall.*; **23**: No. 10, 1163-1171(Oct 1975).

The coarsening behavior of two Cu--Ni--Fe alloys was found to include a discontinuous reaction which originates at larger misorientation grain boundaries. Segments of these boundaries migrate at a rate depending on temperature and time and consume the semicoherent matrix spinodal, leaving behind larger irregularly shaped semicoherent particles in a cellular morphology. The combined influence of a dominant driving force (reduction in total interphase interfacial energy) and sluggish boundary migration rate promotes additional coarsening among the boundary-fed particles, wherein their effective interparticle spacing ($lambda_2$) varies as $lambda_2 = k_2 t^{0.7}$, compared to that of the matrix, $lambda_1 = k_1 t^{0.34}$. In both cases the rate of coarsening is greater in the alloy of asymmetrical composition than in the symmetrical alloy. No satisfactory account of Cu--Ni--Fe discontinuous coarsening reaction kinetics can be made based upon current theories of thermally activated growth processes. (auth)

MECHANICAL PROPERTIES

3403 (CONF-751106—3) High strain rate tensile properties of annealed 2 1/4 Cr—1 Mo steel. Klueh, R.L.; Oakes, R.E. Jr. (Oak Ridge National Lab., Tenn. (USA); Oak Ridge Y-12 Plant, Tenn. (USA)). 1975. 28p. Dep. NTIS $5.00.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

The high strain rate tensile properties of annealed $2^1/_4$ Cr-1 Mo steel were determined and the tensile behavior from 25 to 566°C and strain rates of 2.67 x 10^{-6} to 144/s were described. Above 0.1/s at 25°C, both the yield stress and the ultimate tensile strength increased rapidly with increasing strain rate. As the temperature was increased, a dynamic strain aging peak appeared in the ultimate tensile strength-temperature curves. The peak height was a maximum at about 350°C and 2.67 x 10^{-6}/s. With increasing strain rate, a peak of decreased height occurred at progressively higher temperatures. The major effect of strain rate on ductility occurred at elevated temperatures, where a decrease in strain rate caused an increase in total elongation and reduction in area. (auth)

3404 (CONF-751106—6) Monotonic and cyclic stress-strain response of annealed 2 1/4 Cr—1 Mo steel. Jaske, C.E.; Leis, B.N.; Pugh, C.E. (Oak Ridge National Lab., Tenn. (USA); Battelle Columbus Labs., Ohio (USA)). 1975. 33p. Dep. NTIS $5.00.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

The stress-strain response of isothermally annealed $2^1/_4$ Cr—1 Mo steel under monotonic and cyclic loadings was characterized at 21 to 593°C. Monotonic stress-strain curves were developed for uniaxial tensile loading of speciments at strain rates of 8.33×10^{-5} and 8.33×10^{-6} s^{-1}. The cyclic stress-strain response was measured for the first 100 fully reversed strain cycles at strain ranges between 0.4 and 3.0 percent under uniaxial loading at a strain rate of 8.33×10^{-5} s^{-1}. The effects of creep, stress-relaxation, and thermal-exposure hold periods on the cyclic stress-strain behavior were also investigated at 510°C. Monotonic stress-strain curves were quantified using a power law relation between stress range and plastic-strain range. Cyclic hardening was observed at temperatures up to 427°C. A mixture of initial cyclic hardening followed by later cyclic softening was seen at temperatures from 482 to 538°C, and cyclic softening was observed at 593°C. One measure of the cyclic stress-strain response was characterized by the ascending path of the stress-strain hysteresis loop for the tenth cycle. The reported results form part of the data base to be used by others in formulating similar general inelastic constitutive equations for analysis of $2^1/_4$ Cr-1 Mo steel components. (auth)

3405 Damage in steel plates from hypervelocity impact. II. Numerical results and spall measurement. Bertholf, L.D.; Buxton, L.D.; Thorne, B.J.; Byers, R.K.; Stevens, A.L.; Thompson, S.L. (Sandia Labs., Albuquerque, NM). *J. Appl. Phys.*; **46**: No. 9, 3776-3783(Sep 1975).

Comparisons of calculated solutions with experimental results for the impact of 9.53-mm-dia nylon sphere on a 12.7-mm-thick steel plate at 5.182 km/s are presented. Numerical solutions are difficult to obtain with existing Eulerian codes ecause of the need for accurate treatment of material strength and the definition of both the material interface and the free surfaces. The large distortion of the nylon sphere and the steel near the impact crater lip also make this a difficult problem for Lagrangian codes unless frequent rezoning is used. Newly developed Eulerian and Lagrangian rezoning codes areused. They give essentially the same solution. The computational results show that in order to obtain agreement with the experiment, it is necessary to account for the α(bcc)in equilibriume(hcp) polymorphic phase change for iron. Calculations also indicate the need to obtain experimentally the correct spall strength for the steel and a description of this measurement is included. Treatment of elastic-plastic response, a good numerical model for fracture, and a high degree of numerical resolution are also shown to be necessary in order to precidt accurately the backspace spallation observed in the experiment. (auth)

3406 (GEAP—14050) **Characterization of type-321H tubing for LMFBR fuel cladding.** Busboom, H.J.; Appleby, W.K.; Challenger, K.D. (General Electric Co., Sunnyvale, Calif. (USA). Breeder Reactor Dept.). Jul 1975. Contract AT(04-3)-893. 41p. AT.

Type-321H stainless steel from air-melted and vacuum-melted ingots was fabricated into thin wall small diameter tubing and characterized for use in LMFBR development programs. Various fabrication routes were employed to provide annealed tubes with different solution heat treatments and grain sizes as well as tubes containing 10 and 20 percent cold work. Characterization of the tubing demonstrated that Type 321 is more complex than Type 304 or 316 and great care must be taken to select thermal-mechanical treatments to optimize grain size and stress-rupture strength. Stress rupture properties of annealed Type 321H are heavily dependent on the final annealing temperature. Higher temperature anneals gave superior stress rupture properties but this advantage was partly offset by the larger grain size which caused severe difficulties in ultrasonic inspection. While cold working improved the short term stress rupture properties, it was found that in most cases the cold worked material was inferior to the annealed material for tests in excess of 1000 hours at temperatures of 1000 to 1300°F. As far as physical and mechanical properties are concerned, it appears probable that Type 321H can be substituted for Type 316 for cladding if adequate attention is paid to heat treatment. (auth)

3407 (IS-M—45) **Properties of steels ausformed by impact extrusion.** Mayer, V.F.; Scott, T.E. (Ames Lab., Iowa (USA)). 1975. Contract W-7405-eng-82. 27p. (CONF-751111—1). Dep. NTIS $5.00.

From Conference on hot deformation of austenite; Cincinnati, Ohio, USA (17 Nov 1975).

Two commercial steels, AISI 4340 and 440A martensitic stainless, were impact extruded at temperatures between 1150 and 1775°F. Single pass reductions from 50 to 94 percent required durations of only about 10^{-3} s at average strain rates in the range 5×10^2 to 2.5×10^3 s^{-1}. Evidence based on mechanical properties, microstructural observations--optical and T. E. M.--and calculated particle growth rates indicates that carbide particles cannot form during the high rate, single pass deformation. Implications consequent to this deduction that are germane to current understanding of the ausform strengthening mechanism are discussed. (auth)

3408 (LBL—4152) **Fe—12Ni—4Co—2Mo—.05Ti alloy for use at 77°K and below.** Whitaker, B.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Oct 1975. Contract W-7405-Eng-48. 65p. Dep. NTIS $5.50.

Thesis.

A variant of the maraging class of steels is proposed for application at 77°K and below where a combination of very high strength and good toughness is required. The alloy has a composition of Fe-12Ni-4Co-2Mo-0.05Ti where low interstitial content. The as quenched and quenched and aged structures were completely martensitic with a prior austenitic grain size of 10 to 12 μm. This structure had a Y.S. of 138.5 ksi and 154 ksi before and after aging respectively. All aging was done at 444°C for 4 hours. The DBTT was shown to lie above 77°K as measured by C/sub v/ testing. Based on dilatometric studies of the α yields γ and γ yields α transformation temperatures a cycling treatment consisting of reportedly heating to above the A/sub f/ temperature followed by a water quench was utilized to further reduce the prior γ grain size to approximately 4 to 6 μm. The structure was completely martensitic and possessed a Y.S. of 151 ksi at 77°K in the unaged condition with a Y.S./K/sub IC/ ratio of 1.9 while the aged structure showed a Y.S. of 162 ksi with a Y.S./K/sub IC/ ratio of 1.3. C/sub v/ testing showed the DBTT to lie between 77°K and 4.2°K. Further grain refinement was accomplished by a 2 phase decomposition procedure which resulted in a grain size of 1 to 2 μm. The structure which contained decreasing amounts of austenite with temperature (3.0 percent at R.T. to 1.0 percent at 4.2°K) showed the best combination of strength and ductility at 4.2°K. A Y.S. of 205 ksi with a Y.S./K/sub IC/ ratio of 0.84 was achieved before aging. The aged structure was brittle at 4.2°K with a Y.S. of 218 ksi and a Y.S./K/sub IC/ ratio of 0.425. (auth)

3409 (RDT-M—4-4T(10-75)) **Alloy steel castings. (ASME SA-217 with additional requirements).** (Oak Ridge National Lab., Tenn. (USA)). 17 Oct 1975. RSO.

A standard prescribing requirements for alloy steel castings (ASME SA-217 with additional requirements), for nuclear and associated applications is presented. This standard supersedes RDTM4-4T, dated July 1971. (JRD)

3410 (SLA—74-0114) **Influence of several design and material specifics on the propensity for solder joint cracking.** Munford, J.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). Mar 1975. Contract AT(29-1)-789. 42p. Dep. NTIS $5.25.

Encapsulated printed wiring board assemblies which are subjected to thermal cycling may be prone to the insidious problem of solder joint cracking. In order to quantitatively assess the susceptibility and resulting reliability of these electronic packages, a series of tests were conducted. Several test units were designed to parametrically evaluate various material and design variables. Thermal cycling (-40°F to +160°F) of these test units with periodic visual and/or electrical examination of each solder joint resulted in a systematic comparison of several variables with regard to propensity for solder joint cracking. Within the limitations of the test conditions, several recommendations can be made to advise designers of the design and production practices to minimize damage to solder joints. (auth)

3411 (WARD-HT—3045-9) **Basic creep-rupture testing at 1100°F (593°C) of uniaxially loaded specimens with uniform sections of Type 304 stainless steel.** Manjoine, M.J. (Westinghouse Electric Corp., Madison, Pa. (USA). Advanced Reactors Div.). Jul 1975. Contract E(11-1)-3045. 268p. AT.

The tests were performed at 1100°F in air on flat uniform gage section models of 304 ss which were uniaxially loaded. Three degrees of plane strain were obtained by laterally constraining the ends and varying the length-to-width ratio. Constant-load tests show that increasing the degree of plane strain will decrease the creep rate, increase the creep strength, and decrease the instability strain at a given creep rate. In interspersed creep straining under increasing step loading, the strain and thermal history are critical: the creep rate is increased, strain rate sensitivity is increased so that the short-time loading strain is decreased, and the instability strain is increased with possibly longer rupture life. Strain distributions were measured. Strain instability is a function of triaxiality and strain rate. A damage criterion is proposed. (103 figures, 11 tables) (DLC)

3412 (ORNL-tr—4038) **Factors affecting the creep rupture strength of steel X6CrNiMo 17 13.** Branch, G.D.; Wickens, A.; Baker, D.W.C. Translated by R.G. Mansfield from *Arch. Eisenhuettenwes.*; **43**: No. 11, 833-837(1972). 10p. Dep. NTIS $4.50.

Results of stress—time to rupture tests on 32 melts showing a chemical composition similar to that of steel x CrNiMo 17 13 at temperatures between 550 and 700°C are presented. Data are included on the 10,000-h creep rupture strength at 600, 650, and 700°C measured by a linear multiple regression analysis with regard to 10 elements of the chemical composition, residual cold deformaton, and grain size as independent variables. The reliability of the equations derived from data taken from the literature are verified and additional data taken from the literature are given. (auth)

3413 Low-temperature thermophysical and mechanical properties of high-purity platinum-25 wt % iridium alloy. Foley, R.J. (Univ. of California, Livermore); Jelinek, F.J. pp 443-445 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

The low-temperature properties of a platinum-25 wt. percent indium alloy were evaluated in the range from 4 to 300°K. The high-purity material was synthesized by consumable arc melting and subjected to a series of cold-work and aging operations to obtain a high-strength, machinable alloy. Values are presented for the thermal contraction and conductivity between 4 and 300°K. Measurements were performed using fused silica dilatometry and longitudinal steady-state methods. Mechanical strength data are reported at 20 and 300°K. In all cases, the material used was 50 percent cold worked and aged at 973°K for 5 h. (auth)

3414 (ORNL-tr—4043) Creep-rupture properties of Hastelloy-X used as structural component in OGL-1. Yokoi, S.; Monma, Y.; Fujimura, T.; Kikuyama, T.; Itami, K. (Japan Atomic Energy Research Inst., Tokyo). 12 Feb 1974. Translation by H. Kubota of JAERI-M—5651. 12p. Dep. NTIS $4.50.

Creep rupture tests were conducted on Hastelloy-X that is the material used for the inner wall tubes of the OGL-1 on the forged base material at 800, 900, and 1000°C and on the electron beam and TIG welded material at 900 and 1000°C, and the following results were obtained: (1) The stress-rupture time relationship for the forged base material was a linear relationship on a log-log plot for all three temperatures. (2) Rupture time of the electron beam weld material was of the same order as that of the base material at both 900 and 1000°C. (3) Rupture time of TIG weld material at 900°C was about the same as that of the base material, but this material ruptured at $^1/_2$-$^1/_3$ the time of the base material at 1000°C. (4) Deformation and rupture modes of the base material were such that localized reduction in area was large to the low-temperature high-stress side, and the intragrain rupture was accompanied by cavity type microcracks. On the other hand, localized reduction in area was virtually nonexistent to the high-temperature low-stress side, and grain-boundary rupture due to wedge-shaped microcracks took place. (5) Rupture in TIG weld material at 1000°C took place through microcracks that formed along the Mo compounds precipitating continuously as large particles at the crystal grain boundaries of the welded metal. (6) The precipitate in the base material to the low temperature high stress side was Mo compounds distributed in uniform and minute manner within the grains, but it was a large Cr—Mo composite compound distributed along the grain boundary to the high temperature low stress side. (7) Large Mo compound precipitate deposited rapidly along the grain boundary of the welded metal of the TIG weld material at 1000°C as a result of which a Mo deficient layer was formed in the base about the precipitate, and this formation weakens the solid solution reinforcement of the base. This behavior is thought to be one factor responsible for the short-term rupture. (auth)

3415 Strain gage method for determining the mechanical properties of filaments. Swearengen, J.C.; Ericksen, R.H. (Sandia Labs., Albuquerque, NM). *J. Test. Eval.*; **2**: No. 6, 547-550(Nov 1974).

A test method has been established which permits utilization of strain gages to obtain mechanical properties of filaments. Uniaxial monotonic load-strain and creep measurements were made using several techniques to verify that the method measures properties representative of the filaments. The method eliminates the requirements of obtaining a compliance calibration of the testing machine and has the advantage of facilitating measurements of small strains in filaments having very high stiffness. (auth)

3416 Calculation of the compressibility coefficients for the alkali and alkaline metals. Reynolds, C.L. Jr.; Couchman, P.R. (Univ. of Virginia, Charlottesville). *J. Chem. Phys.*; **62**: No. 2, 738-739(15 Jan 1975).

Compressibility coefficients for Li, Na, K, Rb, Cs, Ca, and Mg are calculated and their correlation is shown. (LK)

3417 Creep-rupture properties, resistance to temper embrittlement and to attack by hydrogen of a 1.4 % Mn—0.25 % Mo—0.03 % Cb steel. Wada, T.; Sponseller, D.L. (Climax Molybdenum Co. of Michigan, Ann Arbor). *J. Eng. Mater. Technol.*; 234-245(Jul 1975).

From Winter annual meeting; Detroit, MI (11 Nov 1973).

A laboratory heat of an improved boiler steel containing 0.13 percent C, 1.36 percent Mn, 0.27 percent Mo, 0.03 percent Nb, and 0.010 percent N was prepared; creep-rupture properties, resistance to temper embrittlement, and resistance to hydrogen attack were investigated. The rupture strength was much higher than that of carbon steel and niobium-treated carbon steel, but was somewhat lower than that of two European carbon-0.3 percent Mo boiler steels. Creep-rupture ductility was high. The experimental steel exhibited high toughness, especially in the normalized and stress-relieved condition. No temper embrittlement was induced by step-cooling normalized or normalized and stress-relieved material. Good resistance to hydrogen attack was revealed by tests in a hydrogen autoclave at a pressure of 1000 psi (6.9 N/mm²); the steel retained the original Charpy impact toughness after exposures up to 5000 h at 900°F (480°C) and 500 h at 1000°F (540°C). No blistering or fissuring were observed. (10 fig) (auth)

3418 Dynamic tensile strength of mercury. Carlson, G.A. (Sandia Labs., Albuquerque, NM). *J. Appl. Phys.*; **46**: No. 9, 4069-4072(Sep 1975).

The dynamic tensile strength of mercury has been determined using very-short-duration (~100 ns) stress pulses generated by an electron-beam machine. Tensile strengths of 1900 MPa (19 kbar) are observed for mercury at maximum tensile stress rates of ~75 MPa/ns. These results are somewhat lower than the value of 3000 MPa predicted by homogeneous nucleation theory. (auth)

PHYSICAL PROPERTIES

3419 (CONF-750859—1) Fabrication and superconducting properties of Nb_3Al multifilamentary composites. Hafstrom, J.W.; Thresh, H.R. (Argonne National Lab., Ill. (USA)). Aug 1975. Contract W-31-109-Eng-38. 18p. Dep. NTIS $4.00.

From Fall meeting of the American Chemical Society; Chicago, Illinois, USA (24 Aug 1975).

The metallurgy, fabrication techniques, and superconducting properties of mono- and multifilamentary aluminum-stabilized Nb_3Al wire fabricated by bulk diffusion processes are presented in detail. Emphasis is placed on the relationship of the superconducting properties to the process parameters. High superconducting critical-current densities are possible in Nb_3Al, fabricated by diffusion, only by increasing flux pinning through reduction of the grain size to below 1 μm. Results of experiments on the control of grain size through the use of nonoxide dispersions and short diffusion times are reported. It was found that the Nb_3Al layer thickness is the most significant influencing J/sub c/(H). Zirconium additions were found to accelerate layer growth thus enabling quite short reaction times. (auth)

3420 (CONF-750913—15) Crystal structure and magnetic properties of americium laves phases. Aldred, A.T.; Dunlap, B.D.; Lam, D.J.; Shenoy, G.K. (Argonne National Lab., Ill. (USA)). Sep 1975. Contract W-31-109-Eng-38. 6p. Dep. NTIS $4.00.

From 4. international transplutonium elements symposium; Baden-Baden, F.R. Germany (13 Sep 1975).

An investigation was made of a series of binary americium alloys with AB_2 stoichiometry (B = Al, Co, Fe, Rh and Ru) prepared from the ^{243}Am isotope. The C-15 ($MgCu_2$-type) structure appears in $AmAl_2$, $AmCo_2$, $AmFe_2$, and $AmRh_2$, whereas $AmRu_2$ is isostructural with $AmOs_2$ which has the C-14 ($MgZn_2$-type) structure. The magnetic properties of the cubic americium laves phases were studied by means of magnetization and nuclear gamna-ray resonance (Moessbauer effect) measurements between 2.5 and 300°K. All the cubic Laves phases studied, except $AmFe_2$, exhibit almost temperature-independent paramagnetism. The $AmFe_2$ sample is ferromagnetic with an estimated Curie temperature of approximately 400°K. The hyperfine field at the Am site in all the compounds is small. The bulk magnetic moment of $AmFe_2$ (approximately 3 μ/sub B//F.U.) is thus associated only with the Fe atoms. The magnetic properties of the compounds are consistent with the assumption that the Am ion is in the +3 state (5f6). (auth)

3421 (CONF-751101—35) Tritium permeation through materials for steam generator systems. Bell, J.T.; Strehlow, R.A.; Redman, J.D.; Smith, F.J.; Savage, H.C. (Oak Ridge National Lab., Tenn. (USA)). 1975. 18p. Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Mixed isotope techniques and experimental apparatus have been developed for determining the rates of tritium permeation through metals at high temperatures. An inert gas or a controlled steam oxidizing atmosphere on the downstream side of the sample is used so that effects of surface oxidation and the formation of oxide coatings to impede tritium permeation can be determined. The validity of the method was demonstrated by determining the tritium permeability of nickel and comparing the tritium values to established hydrogen and deuterium permeabilities. The methods were applied in a long-term experiment by measuring tritium permeation through Incoloy 800 at 657°C with the downstream side of the sample continuously treated with a 750 torr sweep gas of $Ar-H_2O$ with the H_2O partial pressure at 240 torr. Oxidation of the metal to form an oxide coating on the metal was accompanied by a decrease in the tritium permeation by a factor of 160 over a period of 84 days. (auth)

3422 (CONF-751209—5) **Analysis of magnetic neutron scattering data.** Felcher, G.; Garland, J.W.; Cable, J.W.; Medina, R. (Argonne National Lab., Ill. (USA)). Dec 1975. Contract W-31-109-Eng-38. 9p. Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Apparent discrepancies exist between the results of diffuse scattering and diffraction experiments for ferromagnetic Ni--Cu alloys. These are found not to arise from the use of the linear Marshall model for the analysis of the diffuse scattering results. The discrepancy found in the limit of zero momentum transfer, K yields 0, is resolved by eliminating the usual assumption of a uniform conduction-electron spin polarization. The discrepancy at large K arises largely from the inexact spherical averaging procedure previously used in the analysis of diffuse unpolarized neutron-scattering data, as is confirmed by polarized neutron scattering. The diffraction and diffuse scattering data are found to be consistent with one another but not with the usual free-ion form factor. They indicate that the negative spin density usually attributed to conduction electrons arises instead largely from the overlap of d-functions. (auth)

3423 (CONF-751209—8) **Moment disturbances in Ni—Cu alloys.** Medina, R.A.; Cable, J.W. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. 9p. Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Magnetic diffuse scattering of polarized neutrons from ferromagnetic Ni--Cu alloys with 19.8, 29.6, and 53.5 at. percent Cu was measured at 4.2°K. Data show that the Cu atoms are not polarized and that the negative polarization exists only around the Ni sites. (auth)

3424 (COO—1569-124) **NMR study of the sublattice magnetizations of Mn_2Sb.** Hu, C.P. (Minnesota Univ., Minneapolis (USA). School of Physics and Astronomy). Dec 1974. 75p. Dep. NTIS $5.50.

Thesis.

The temperature dependence of the sublattice magnetizations of Mn_2Sb was measured from 1.5 to 150°K. Data are in agreement with spin-wave theory and with a phenomenological model which suggests that one site of Mn atoms has 3-D structure while the other site has 2-D structure. Other models gave poor results, owing to the fact that the magnetic structure of Mn_2Sb is not entirely understood. The NMR resonance of the Mn(I) site was observed only below 2°K using modulated c-w spectroscopy, with broadening above this temperature. (DLC)

3425 (LA—6092-MS) **Thermal conductivity of uranium: effects of purity and microstructure.** Sandenaw, T.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-Eng-36. 8p. Dep. NTIS $4.00.

Thermal conductivity curves for polycrystalline uranium are presented for the temperature range below 373°K. The curves are for specimens prepared by different fabrication procedures from material of known purity and hardness. Included is a curve for U/2wt percent Mo alloy. Different mechanisms appear to be influencing the thermal conductivity behavior of uranium in well-defined temperature regions: below 37 to 43°K, approximately 40 to approximately 80°K, 80 to approximately 280°K, and from 280°K to the α yields β transformation temperature. Mechanisms responsible for results in one temperature region continue to exert a strong influence in the next higher temperature region. Impurities and initial microstructure seem to influence results at any starting temperature. Evidence is presented for the possibility of imperfection ordering in uranium between approximately 40 and approximately 280°K. It is postulated that the type of ordering is capable with a martensite-like behavior and that all physical property results depend on the extent of a modification of the α-phase on cooling below approximately 280°K. (auth)

3426 (LBL—4123) **Reactions and wetting behavior in the molten aluminum-fused silica system.** Marumo, C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 59p. Dep. NTIS $5.50.

Thesis.

The sessile drop technique was used to study the wetting behavior of fused silica by molten aluminum in the temperature range 800 to 1000°C, and provided the specimens for the reaction studies. Contact angle between fused silica and molten aluminum decreased down to 90° mainly due to the contribution of the free energy of the reaction (-)Δg to the solid-liquid interfacial tension γ/sub sl/ and due to the change of the surface tension γ/sub lv/ of molten aluminum which dissolves silicon as a result of the reaction. Below 90°, the periphery of the drop was in contact with the intermediate reaction layer. Three reaction layers, I (adjoining the drop), II, III (adjoining SiO_2) were formed. The main reaction layer I-b at 800°C is identical to layer I-a at 900°C; and the thin layer at 800°C is identical to layers II-a and III-a at 900°C. Using an Al drop saturated with Si at 800°C, two reaction layers II-c and III-c were formed; a layer equivalent to I-a and I-b was not present. Possible reaction mechanisms between Al and SiO_2 are proposed. At the test temperature layer I is assumed to be A10 which is stabilized by forming a solid solution with SiO and Al_2O, and layer III is assumed to form a spinel type structure (XA10(1-x)SiO)Al_2O_2then proceed by counterdiffusion of Al ions and Si ions through
the reaction layers. At room temperature, the reaction products dissociate to form crystalline Al_2O_3, Al, and Si. (auth)

3427 (SAND—75-5807) **Pressure dependence of the electronic structure of nickel.** Anderson, J.R.; Heimann, P.; Schirber, J.E.; Stone, D.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-751209—9). Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

The influence of pressure on de Haas--van Alphen frequencies in nickel was studied by means of both fluid helium and solid helium phase shift techniques. Two pieces of Fermi surface were investigated, the copper-like majority-spin necks and the minority spin hole pockets. The changes are small; for example, the effect of pressure on the nickel necks is much less than for the necks in copper. (auth)

3428 **Influence of fast neutron and fission damage on critical data of high-field superconductors.** Bauer, H. (Univ., Giessen, Ger.); Saur, E.J.; Schweitzer, D.G. pp 343-346 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

Wire samples of high-field superconductors with A 15 and B 1 structure, some of them doped with small amounts of ^{10}B and ^{235}U, were irradiated at room temperature by fast and thermal neutrons with doses up to 1 x 10^{19} neutrons/cm^2. For samples with A 15 structure the critical currents in transverse fields can be increased up to 460 percent by irradiation. On highly damaged samples drastic reductions in the current-carrying capacity, the critical temperature and indications of a decrease of the upper critical field are found as well as lattice expansions. Superconductors with B 1 structure are much less sensitive to irradiation than A 15 materials. (auth)

3429 **Spin polarization near iron group atoms in copper.** Boyce, J.B.; Aton, T.; Stakelon, T.; Slichter, C.P. (Univ. of Illinois, Urbana). *Pure Appl. Chem.*; **40**: No. 1-2, 141-148(1974).

Dilute solutions of iron group atoms in Cu are of interest in the general problem of the occurrence of magnetism and also for the Kondo effect. One way in which the Kondo effect manifest itself is through a magnetic susceptibility obeying a Curie-Weiss law X = C/(T + T/sub k/) (where C is a constant, T the temperature and T/sub k/ the so-called Kondo temperature), rather than Curie's law. Some theories and experiments have suggested that the spin polarization near the magnetic atom undergoes a significant change in shape when T is cooled below T/sub k/. NMR measurements of the conduction electron spin polarization $\sigma(r)$ at various copper sites near to V, Cr, Mn and Fe impurities in dilute (~0.1 percent) alloys are reported. Results on single crystals of CuCo are also reported. The Cu atoms near the magnetic atom experience at Knight shift (relative to the resonance of pure metallic Cu) which is proportional to $\sigma(r)$. Theoretical expressions are given relating $\sigma(r)$ to the magnetic properties of the impurity atom. Results are presented on $\sigma(r)$ down through the 29°K Kondo temperature of CuFe in four neighboring shells of Cu and has thus been enabled to test for the first time whether or not there is a shape change in $\sigma(r)$ associated with the Kondo condensation. No shape change was found. (auth)

3430 Calorimetric studies on actinide compounds and materials of interest in reactor technology. O'Hare, P.A.G.; Ader, M.; Hubbard, W.N.; Johnson, G.K.; Settle, J.L. (Argonne National Lab., IL). pp 439-453 of In Thermodynamics of nuclear materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.2); CONF-741030—P2.

Standard enthalpies of formation, ΔH^{o}/sub f/, at 298.15°K, based on solution-reaction or fluorine bomb calorimetric measurements are reported for the following compounds: α-Li_2UO_4, K_2UO_4, $RbUO_4$, $Cs_2U_2O_7$, $Cs_2Mo_2O_7$, Cs_2CrO_4, Li_3N, Li_2O, $ThS_{1.029}$, $MoC_{0.502}$, $MoC_{0.451}$, U_3Si, and β-US_2. The results are compared with earlier determinations and the significance of some of the data vis-a-vis the chemistry of processes in irradiated fuel pins is discussed. (auth)

3431 Mictomagnetic to ferromagnetic transition in Cr—Fe alloys. Shull, R.D.; Beck, P.A. (Univ. of Illinois, Urbana). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 95-96(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The bcc Cr--Fe solid solutions are mictomagnetic in the composition range 9 to 23 at. percent Fe. The change to ferromagnetism is gradual, but alloy $Cr_{75}Fe_{25}$ is essentially ferromagnetic. By analyzing the paramagnetic data, the average giant moment of the magnetic clusters was determined as a function of temperature and composition. The discrepancy between the Curie temperature of $Cr_{75}Fe_{25}$ and the "kinkpoint" temperature measured in a steady 113 Oe field is interpreted in terms of a relaxation effect. (auth)

3432 μ^+ studies of critical spin fluctuations in Ni. Patterson, B.D. (Univ. of California, Berkeley); Magamine, K.; Bucci, C.A.; Portis, A.M. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 281-282(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Critical fluctuations above the Curie point in nickel were studied by observing the relaxation of the free precession of positive muons. This work was prompted by the apparent discrepancy in nickel spin correlation time as determined by neutron scattering and by perturbed angular correlation (PAC) experiments. Up to 20°K above the Curie point, the temperature dependence is in agreement with that determined from PAC. At higher temperatures, the computed nickel spin correlation time becomes independent of temperature. The observed high temperature muon relaxation time of 16 μs is very much shorter than expected from either the observed contact field at the low temperature muon site or from classical dipolar coupling to the muon nearest neighbors. The increased relaxation rate may arise from an enhanced pseudodipolar interaction. (auth)

3433 Small-angle neutron scattering from cobalt in the critical region. Glinka, C.J. (Univ. of Maryland, College Park); Minkiewicz, V.J.; Passell, L. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 283-284(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The temperature dependence of the small-angle critical scattering of neutrons from cobalt was measured both above and below its Curie temperature, T/sub c/. Below T/sub c/ the scattering is dominated by well-defined spin wave modes which exhibit nearly quadratic dispersion. As T/sub c/ is approached, the spin waves renormalize and broaden but no evidence of the longitudinal component of the susceptibility is observed. Above T/sub c/, the exponents $\gamma = 1.23 \pm 0.05$ and $\nu = 0.65 \pm 0.04$, describing the power law dependence of the static susceptibility and the inverse correlation range, respectively, were obtained from the small-angle scans after taking full account of the inelasticity of the scattering. The energy widths of the scattering above T/sub c/ were measured and are well described by a dynamical scaling function over a range of temperature and wave vector extending throughout the critical region and well into the hydrodynamic regime. (auth)

3434 Dynamic susceptibility calculations in ferromagnetic iron. Cooke, J.F.; Lynn, J.W.; Davis, H.L. (Oak Ridge National Lab., TN). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 329-330(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Calculations of the low temperature dynamic susceptibility of ferromagnetic iron were carried out within the framework of an itinerant electron model. The formalism incorporates band and wave vector dependent matrix element effects and is essentially the same as that used in previous work on nickel. The spin wave dispersion curves calculated along the three principal symmetry directions are found to be in excellent agreement with neutron scattering experiments. In addition the calculations predict correctly the experimentally observed spin wave disappearance. These results indicate that low-temperature spin waves in both nickel and iron can be adequately described in terms of an itinerant electron model without recourse to ad hoc assumptions about local moment behavior. (auth)

3435 Magnetic form factor of electrons in 3d bands. Moon, R.M. (Oak Ridge National Lab., TN). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 425-427(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The formalism for calculating the spin density or magnetic form factor for tight-binding band electrons is considered in the case where nearest-neighbor overlap is not negligible. The formalism leads to a description of the system in terms of a two-component form factor, one of which is identical to the atomic form factor and the other is related to the diffuse overlap density. Numerical calculations for Fe and Ni show that the net overlap density is opposite in direction to the atomic spin. Comparison with experiment is presented for the case of Fe. (auth)

3436 Magnetic properties of MnPt and CoPt. Chen, C.W.; Buttry, R.W. (Ames Lab., IA). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 437-438(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetization measurements were conducted on ordered and disordered polycrystalline specimens of MnPt and three Co--Pt alloys between 4.2 and 293°K. The magnetic data, while confirming the onset of antiferromagnetism in the ordered MnPt, reveal the presence of ferromagnetic regions in the disordered MnPt. Chemical order tends to exert a pronounced (~30 percent) adverse effect on saturation magnetization (M/sub s,0) of the Co--Pt alloys at 0°K near the equiatomic composition. Meanwhile, the effect of Co concentration on M/sub s,0/ of the Co--Pt alloys is shown to be appreciable only when the Co content exceeds 50 percent. (auth)

3437 Moessbauer studies of dilute Ag:Fe and Ag:Co alloys. Thompson, J.R.; Thomson, J.O. (Oak Ridge National Lab., TN). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 477-478(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The dilute Kondo alloys Ag:^{57}Fe and Ag:^{57}Co were studied via the Moessbauer effect at temperatures between 0.022K and 20K and in applied magnetic fields from 0 to 60 kG. This allows study of both the thermal and magnetic breakup of the nonmagnetic gound state. The higher temperature results are consistent with those of Kitchens, Steyart and Taylor. As the temperature is lowered, a strong reduction from free spin behavior of the local moment is observed. At the lowest temperatures the dependence of the Fe hyperfine field on applied field is compared with several theoretical and semiempirical expressions; each describes the data moderately well, none with marked superiority. The first measurements of the hyperfine field of ^{57}Co in Ag are also reported, obtained via the intensity asymmetry of the spectra. The field can be described in terms of a large positive Knight shift $K = (28 \pm 8)$percent. The small magnitudes of the hyperfine fields result from the negative core polarization fields being offset by positive orbital fields and illustrate the importance of orbital effects. (auth)

3438 Comparison of band structures and charge distributions of copper and silver. Fong, C.Y. (Univ. of California, Davis); Walter, J.P.; Cohen, M.L. *Phys. Rev., B;* **11**: No. 8, 2759-2767(15 Apr 1975).

The band structures of copper and silver calculated using the empirical-pseudopotential method are presented. The density of states for silver obtained from the band structure is compared with results of photoemission experiments. The charge distributions of the two metals were calculated in the (100) plane. A comparison of the distributions is made with reference to the results of the band structures. (auth)

3439 Optical properties of Ti, Zr, and Hf from 0.15 to 30 eV. Lunch, D.W. (Ames Lab., IA); Olson, C.G.; Weaver, J.H. *Phys. Rev. Lett.;* **11**: No. 10, 3617-3624(15 May 1975).

The absorptivity or reflectivity of polycrystalline samples of Ti, Zr, and Hf was measured from 0.15 to approximately 30 eV.

The data were Kramers-Kronig analyzed to determine the dielectric functions. Between approximately 0.2 and approximately 7 eV, each metal showed five structures in the absorptivity and epsilon$_2$. These were interpreted as interband transitions within the d bands. The epsilon$_2$ spectra had minima near 7 eV similar to that observed in the bcc transition metals. Additional structures at higher energy could be related to transitions involving highlying bands and the core levels. The electron-energy-loss functions were calculated and discussed in terms of volume and surface plasmons. These metals, like the other transition metals studied, exhibited two volume and two surface plasmons. (14 fig, 3 tables, 32 references) (auth)

3440 Short-range order and the electronic structure of a one-dimensional liquid metal. Peterson, H.K.; Schwartz, L.M. (Waltham, Univ., MA). *Phys. Rev. Lett.;* **11**: No. 10, 3678-3688(15 May 1975).

The energy spectrum of a one-dimensional array of δ-function potentials is studied as a function of the degree of short-range order in the arrangement of the scatterers. The integrated density of states is evaluated numerically and the results are used to compare alternate theoretical formalisms. In particular, Lax's quasicrystalline approximation (QCA) and the more recent self-consistent approaches of Gyorffy and Schwartz and Ehrenreich are considered. Surprisingly, it is found that only the non-self-consistent QCA yields a reasonable description of the electronic spectrum. The failure of the self-consistent schemes appears to be due to an incomplete treatment of the multiple-occupancy corrections. (auth)

3441 Dispersion of nonlinear optical susceptibilities of InAs, InSb, and GaAs in the visible region. Bethune, D.; Schmidt, A.J.; Shen, Y.R. (Univ. of California, Berkeley). *Phys. Rev. Lett.;* **11**: No. 10, 3867-3875(15 May 1975).

The dispersion of parallel chi/sup (2)/(2ω)parallel for the III-V semiconductors InAs, InSb, and GaAs at 80 and 300°K was measured, with hω between 2.0 and 2.7 eV. Large dispersion in parallel chi/sup (2)/(2ω)parallel is found for all three semiconductors, while the results for the two temperatures are similar. The observed structures in chi/sub (2) with those in chi/sup (1)/ ω) and chi/sup (1)/(2ω), and Miller's Δ derived from the experimental values. The measured chi/sup (2)(2ω) is also compared with recent theoretical results obtained from empirical pseudopotential calculations. (8 fig, 36 references) (auth)

3442 Coexistence of superconductivity and the Kondo effect in PbCe and InCe quench-condensed films. Delfs, R.J.; Beaudry, B.J.; Finnemore, D.K. (Ames Lab., IA). *Phys. Rev., B;* **11**: No. 11, 4212-4218(1 Jun 1975).

Both systems show a Kondo effect and a regular depression of the superconducting transition temperature. Results show that the onset of superconductivity causes major changes in the formation of the Kondo state. (auth)

3443 Heat capacity and magnetic susceptibility of single-phase α-cerium. Koskimaki, D.C.; Gschneidner, K.A. Jr. (Ames Lab., IA). *Phys. Rev., B;* **11**: No. 11, 4463-4469(1 Jun 1975).

The heat capacity of single-phase α-cerium was measured from 1.6 to 22°K and the magnetic susceptibility from 1.6 to 150°K. The electronic-specific-heat constant was found to be 12.8 +— 0.2 mJ (g atom)$^{-1}$ K^{-2} and the Debye temperature at zero degrees was found to be 179 +— 2°K. The susceptibility results show a skewed U type of temperature behavior with minimum of 3.77 x 10^{-6} emu g^{-1} near 50°K and a rapid rise of about 20 percent below 20°K. Results are interpreted according to various models for the nature of α-cerium and the α reversible γ transition. (auth)

3444 Nature of the Griffiths singularity in dilute magnets. Harris, A.B. (Sandia Labs., Albuquerque, NM). *Phys. Rev., B;* **12**: No. 1, 203-207(1 Jul 1975).

The nature of the singular behavior pointed out by Griffiths for H = 0 in dilute magnets is investigated. It is argued that for concentration p less than that for formation of an infinite cluster, all derivatives of M(H) are finite. The nonanalyticity in M(H) is due to a branch cut along the imaginary H axis having weight exp[-(const)/parallel H parallel] for parallel H parallel yields 0, and is thus too weak to be experimentally observable. Some numerical and exact analytic results for the dilute magnet on a Bethe lattice are presented. (auth)

3445 Temperature dependence of the rate of positron trapping by vacancies in gold. Hall, T.M. (Brookhaven National Lab., Upton, NY); Goland, A.N.; Jain, K.C.; Siegel, R.W. *Phys. Rev., B;* **12**: No. 5, 1613-1619(1 Sep 1975).

Positron lifetimes were measured in high-purity gold in order to study the temperature dependence of the monovacancy-positron specific trapping rate, defined as the positron trapping rate per unit monovacancy concentration. In all cases a positive temperature dependence was found. Equilibrium experiments alone yielded a temperature dependence of T/sup 0.5 +- 0.2/ over the temperature range 673 to 1033°K. Experiments which combined quenching and equilibrium measurements indicated a temperature dependence of T /sup 0.9 +-0.1/ between 243 and 1033°K. Additional measurements at lower temperatures indicated that a positive temperature dependence continues down to 115°K. (auth)

CORROSION AND EROSION

3446 (HAN—64841) **AEC uranium fire experience.** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 17 Sep 1954. 27p. Dep. NTIS $4.50.

An inquiry was made to all Operations Offices soliciting literature references on any research on U fires, case histories of any fires involving massive U, and suggestions for research on U fire properties. Replies, a field trip to AEC contractor sites, and a review of individual fire reports form the basis of this report. Five basic types of U fires are distinguished. Water and H_2 were found to increase the pyrophoricity of U. Recommendations are given for a research program. (DLC)

3447 (LA-UR—75-1628) **System for studying the initial states of gas-metal reactions.** Andrews, G.H. Jr.; Alire, R.M.; Czanderna, A.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 11p. (CONF-751023—1). Dep. NTIS $4.00.

From 22. national vacuum symposium; Philadelphia, Pennsylvania, USA (28 Oct 1975).

An ultrahigh vacuum system was constructed for use in conjunction with a Rodder ultramicrobalance for gravimetric studies of metal-gas reactions. Though intended specifically for the study of the early stages of uranium oxidation, the apparatus and techniques are readily adaptable to other metal-gas systems. The system is pumped by sorption, titanium sublimation, and noble ion pumps, which avoid the need for oil diffusion pumping thus eliminating the possibility of sample contamination by oil vapor. Provisions for in situ sputter cleaning of samples as well as electron beam heating and infrared thermometry were built into the system. Gas compositions are monitored with a residual gas analyzer. (auth)

3448 (SC-RR—64-605) **Material interactions of the operational SNAP-9A generator.** Sasmor, D.J.; Wessling, F.C. Jr. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jun 1964. 35p. Dep. NTIS $4.75.

Declassified 20 Oct 1975.

The design of the SNAP-9A generator includes a number of different materials in intimate contact. The possible interactions among the materials and their effect on the postulated re-entry breakup sequence of the generator are discussed. Experimental evidence obtained under static vacuum conditions for all of the interactions possible is presented. (auth)

3449 (UCRL—51869) **Exposure of high-temperature alloys in carbonaceous gas atmospheres.** Goldberg, A.; Perkins, A.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Sep 1975. Contract W-7405-Eng-48. 24p. Dep. NTIS $4.00.

Light and scanning electron microscopy were used to evaluate changes resulting from exposure of eight commercial high temperature alloys in carbonaceous atmospheres. Samples were exposed in CO, CH_4, or CO/CH_4 mixtures up to 900°C and 6.2 MPa. All alloys were actively attacked. Surface finish and preoxidation influenced the extent of corrosion. Reduction of NiO, giving a high surface concentration of Ni, promoted catalytic decomposition of CH_4. Further work is indicated before the performance of these alloys may be ranked with confidence. (auth)

3450 (UCRL-Trans—10943) **Corrosion cracking tests on high-strength pipes.** Purmensky, J.; Sejnoha, R.; Blahoz, O. *Sb. Ved. Pr. Vys. Sk. Banske Ostrave, Rada Hutn.;* **17**: No. 3, 141-157(1971). 22p. Dep. NTIS $4.50.

A method of stress corrosion cracking testing of pipes is described. Steel pipes were tested to determine the relations between fracture time and stress loads. The corrosion medium used was an aqueous solution of KNO_3—NH_4NO_3. Both deformation and stress can be controlled using the test method. An annealing procedure for steels to improve corrosion resistance is also described. (JRD)

3451 (UCRL-Trans—10920) **Investigations of the corrosion cracking of steel Kh18N10T in media containing chloride and hydrogen sulfide.** Maksimova, G.F.; Yushmanova, T.A. Translated from *Korroz. Zashch. Neftegazov. Prom-sti.;* No. 9, 8-10(1972). 8p. Dep. NTIS $4.50.

In connection with the development of new fields of gas containing large amounts of H_2S and chlorides in the formation water, and with the need to select materials for equipment used to extract and dry this gas, it has become necessary to study the features of the corrosion cracking of metals in media containing, in addition to chlorides, H_2S dissolved in the aqueous and hydrocarbon phases. It was found that aqueous solutions of H_2S induce sulfide corrosion cracking of stressed austenitic steel Kh18N10T the faster, the lower is the pH of such solutions. Steel after preliminary cold deformation proved to be most sensitive to sulfide corrosion cracking. Quenching of steel Kh18N10T does not eliminate its tendency toward sulfide corrosion cracking. Steel Kh18N10T cannot be recommended for equipment used in the gas industry in contact with moist H_2S-containing media. (auth)

3452 Wedging action of UH_3 during slow crack growth in U-0.75 wt% Ti. Magnani, N.J. (Sandia Labs., Albuquerque, NM). *Corrosion;* **31**: No. 9, 337-338(Sep 1975).

While uranium alloys have been observed to stress corrosion crack in a variety of environments, a previous study has shown that the principal stress corrodent for U-0.75 Wt percent Ti in air and aqueous environments is H_2O. Since uranium alloys, particularly alloys with low alloy additions, react rapidly with H_2O to form uranium oxide and H_2, a program was initiated to determine the cracking behavior of U-0.75 Wt percent Ti in H_2. Preliminary data obtained from material aged at 357°C for 18 hours (sigma/sub ys/ approximately equal to 900 Mn/m², 130 ksi) and tested in 100 torr of H_2 are given. (auth)

3453 Hydrogen embrittlement of molybdenum. Birnbaum, H.K. (Atomic Energy Research Establishment, Harwell, Eng.); Wadley, H. *Scr. Metall.;* **9**: No. 10, 1113-1116(Oct 1975).

Results of tension tests at 279°K on fine-grained polycrystalline Mo sheet specimens are reported. It was found that under conditions of simultaneous tension testing and cathodic charging, the hydrogen is present at high fugacity at the tip of a crack or other stress concentrations. Thus hydrogen entry into the lattice in relatively high concentrations is possible at the point where it is most effective in causing fracture, the crack tip. Under these conditions, significant hydrogen embrittlement of molybdenum occurs. (auth)

RADIATION EFFECTS

3454 (BNWL-SA—5405) **Effects of hydrostatic pressure on Stage III recovery in irradiated and cold-worked molybdenum.** Kissinger, H.E.; Brimhall, J.L.; Simonen, E.P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 8p. (CONF-751006—11). Dep. NTIS $4.50.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The Stage III recovery temperature is lowered when irradiated or cold-worked molybdenum is annealed under pressure. In irradiated samples, the pressure effect can be explained in terms of an activation volume, negative in sign, which decreases in magnitude with increasing fluence. For cold-worked molybdenum, the pressure effects are not compatible with the activation volume hypothesis. This suggests that recovery mechanisms for the two types of damage can not be considered identical, the differences probably arising from substructure features characteristic of the damage states. (auth)

3455 (BNWL-SA—5450) **Effect of helium on void swelling in vanadium.** Brimhall, J.L.; Simonen, E.P. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 5p. (CONF-751101—34). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Little difference in void microstructural swelling of vanadium is observed when helium is injected simultaneously with a 46- or 5-MeV nickel beam as compared to no helium injection, at least at high dose rates. At lower dose rates, a strong helium effect is seen when the helium is injected prior to heavy ion bombardment. The effect of the helium is shown to be a strong function of the overall displacement damage rate. (DLC)

3456 (CONF-750962—1) **Radiation damage considerations.** Frost, B.R.T. (Argonne National Lab., Ill. (USA)). Aug 1975. Contract W-31-109-Eng-38. 23p. (CONF-750954—1). Dep. NTIS $4.25.

From Colloquium on fundamental aspects of structural alloy design; Seattle, Washington, USA (15 Sep 1975).

The designs of nuclear fission and fusion power plants do not, in general, appear to make unusual demands on materials in terms of mechanical-property requirements. Radiation environments produce unique effects on the composition, microstructure, and defect population of these alloys, resulting in time-dependent and time-independent changes in mechanical properties. To illustrate these problems, the materials needs of the core of a Liquid-Metal Fast-Breeder Reactor (LMFBR) and of the first wall of a fusion reactor are discussed. In the case of the LMFBR core, the phenomenon of void swelling causes serious design problems, and a search is being made for a low-swelling alloy that has adequate mechanical properties. The fusion reactor poses different problems because the neutron energy is high (14 MeV) and is accompanied by a high flux of charged particles. The long-term choices for a wall material have been narrowed to vanadium and niobium alloys. In the search for low-swelling alloys, it has become clear that minor elements play an important role in determining the nature of the radiation effects. The segregation of minor elements to void surfaces and the dispersion and reformation of second-phase precipitates are two important radiation-induced phenomena that require additional study in view of their influence on void swelling and high-temperature properties. (auth)

3457 (CONF-750982—1) **Effects of precipitation on electron displacement damage in FCC alloys: copper alloys with random and modulated microstructures.** Carpenter, R.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.00.

From 4. high voltage electron microscopy conference; Touliuse, France (1 Sep 1975).

Observations on the electron displacement damage behavior of spatially random precipitate in Cu-Co alloys and the modulated structure in Cu-Ti alloys are reported. A few observations of the damage structures in cellularly decomposed Cu-Ti were also made. Results show that (a) metastable quenched solid solution Cu-2wt percent Co alloys, or the same alloys aged to produce coherent Co-rich zones, do not differ greatly from elemental Cu in their behavior under 1 MeV electron irradiation. When the same alloys are aged to form longer incoherent precipitate prior to HVEM irradiation, suppression of the early small loop stage of damage occurs but voids are nucleated in both cases; (b) metastable modulated microstructures in quenched or low temperature aged Cu-4wt percent Ti alloys completely surpressed void nuclcation up to fluences on the order of 50 dpa. The very fine scale microstructural changes that occurred during irradiation in the modulated Cu-4wt percent Ti alloys were not resolved in detail, but it appears that the basic difference between Cu-4wt percent Ti and Cu-2wt percent Co was a much larger point defect sink density in the former, resulting in suppression of void nucleation. Since only one irradiation temperature was investigated, namely approximately 300°C, these conclusions cannot be taken as a general statement concerning the merits of modulated structures with respect to radiation damage, but the results are encouraging. Certainly microstructural coarsening is to be expected during irradiation if the temperature is much above 350°C, and the results may be quite different. (auth)

3458 (HEDL-SA—1012) **Fundamentals of displacement production in irradiated metals.** Doran, D.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 38p. (CONF-750952—3). Dep. NTIS $5.00.

From Seminar on radiation-produced defects and defect clusters and their effects in metals; Ames, Iowa, USA (28 Sep 1975).

Radioinduced displacement damage in metals is described. Discussions are included on the displacement event itself, calculation of displacement rates in general, the manner in which different types of radiation interact with metals to produce displacements, the similarities and differences in the types of damage produced, the current status of computer simulations of displacement cascades, experimental evidence regarding cascades, and aspects of correlating damage produced by different types of radiation. (auth)

3459 Superconductivity and atomic ordering in neutron-irradiated Nb_3Al. Sweedler, A.R.; Cox, D.E. (Brookhaven National Laboratory, Upton, New York 11973). *Phys. Rev., B;* **12**: No. 1, 147-156(1 Jul 1975).

The technique of neutron-induced disorder was used to study the effect of atomic ordering on the superconducting transition temperature T/subc/ of the A-15 compound Nb_3Al. Large depressions in T/subc/ are observed when Nb_3Al is irradiated with high-energy neutrons (E > 1 MeV) at 140°C. For samples whose value of T/subc/ before irradiation was 18.7 K no superconductivity was oberved to 1.4 K after irradiation to a fluence of 1.4 times 10^{19} n/cm². The widths of the transition temperatures remain constant as T/subc/ is depressed and T/subc/ is recovered by annealing at 750°C after irradiation. The Bragg-Williams long-range-order parameter S was determined by least-squares analysis of neutron-diffraction data from powdered samples both before and after irradiation. A reduction in S of 18% is observed for samples irradiated to a fluence of 1.2 times 10^{19} n/cm². For the same fluence

T/subc/ is depressed to 52% of its value before irradiation. The lattice parameter a_0 of the A-15 phase expands upon irradiation, increasing from 5.183 A for unirradiated samples to 5.200 A for samples irradiated to 5.0 times ^{19} n/cm^2. The results are discussed in terms of A-site occuptation in the A_3B A-15 structure and extrapolations of T/subc/ for complete order are considered.

3460 Low-temperature energy release in platinum after ion radiation. Jackson, J.J. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev., B;* **12**: No. 4, 1217-1226(15 Aug 1975).

The release of stored energy and the change of resistivity were measured simultaneously in the same specimen during the annealing from 15 to 35 K of platinum irradiated with 20-MeV deuterons. The calorimeter and differential power analysis used are described in detail. The work was undertaken to determine whether the enhanced initial rate of resistivity increase during the irradiation of quenched platinum, as compared to the rate in annealed platinum, results from greater Frenkel-pair production or a larger Frenkel resistivity in the quenched material. The results indicate that most of the enhancement in these irradiations represents increased production. The resistivity increment per defect added by the irradiation when measured at 5 K is increased only a few percent by the vacancies from the quench. The additional interstitials are preferentially deposited near these vacancies. Using an estimated energy stored in each Frenkel pair of 6 eV the resistivity increment at 5 K of unit concentration of Frenkel defects in platinum is 12 times 10^{-4} Ω cm.

3461 Comment on "free migration of interstitials in tungsten". Seidman, D.N.; Wilson, K.L.; Nielson, C.H. (Cornell Univ., Ithaca, NY). *Phys. Rev. Lett.;* **35**: No. 15, 1041-1042(13 Oct 1975).

Results are briefly summarized of an extensive series of recent field-ion microscope experiments on ion-irradiated (20-and 30-keV W^+) tungsten (with residual resistance ratios varying from 5 x 10^4 to 5), tungsten specifically doped with carbon, and tungsten—0.5-at. percent- and 3-at. percent-rhenium alloys. The experiments are all consistent with the long-range migration of a self-interstitial atom occurring at approximately 38°K. This result is contrasted to the recent conclusions of Okuda and Mizubayashi. (auth)

CERAMICS, CERMETS, AND REFRACTORIES

3462 (LA—4005) **Development of ZrC-coated UC-ZrC particles.** Savage, A.W. Jr.; Feber, R.C.; Bertino, J.P.; Baxman, H.R.; O'Rourke, J.A.; Bard, R.J. (Los Alamos Scientific Lab., N.Mex. (USA)). Contract W-7405-eng-36. 12p. Dep. NTIS $4.50.

Declassified 11 Jun 1975.

Zirconium carbide coatings were deposited on $U_{0.2}Zr_{0.7}C$ cores from zirconium tetrachloride-methane-hydrogen-helium mixtures at 1400°C in an attempt to develop improved coated particles for use in Rover graphite-matrix fuel elements. The coated particles were tested at 2500°C. Those with coatings thin enough to satisfy the requirements of small particle size and high uranium content survived heating in a tungsten container but failed when heated in graphite crucibles, presumably owing to rapid diffusion of carbon through the ZrC coating and formation of a low melting (2400°C) ternary eutectic with the core. Increasing the coating thickness from about 20 to about 45 μ enabled the particles to withstand heating in graphite at 2500°C because of the interdiffusion of core and coating to form a higher melting solid solution, but the uranium content of these particles was too low for use in Rover graphite-matrix fuel elements. (auth)

PREPARATION AND FABRICATION

3463 (COO—2408-2) **Pressure sintering and creep deformation: a joint modeling approach. Progress report, January 1, 1975—December 31, 1975.** Notis, M.R. (Lehigh Univ., Bethlehem, Pa. (USA)). Sep 1975. Contract E(11-1)-2408. 15p. Dep. NTIS $4.50.

Studies were continued to compare the densification during later stages of pressure sintering to the creep deformation behavior for CoO and $MgAl_2O_4$ as a function of stress, temperature, grain size, and porosity. A multimechanism model combining both linear and nonlinear plastic flow elements was developed and densification maps were developed assuming that each of these elements are independent. Studies of the densification kinetics during final stage pressure sintering of both CoO and $MgAl_2O_4$ are interpreted in terms of both phenomenological and atomistic constitutive densification rate equations. For CoO, the densification kinetics indicate that at low stresses linear viscous mechanisms predominate, and that at higher stresses nonlinear plastic deformation mechanisms are operative; the rate-controlling process appears to be cation-lattice diffusion at low stresses and oxygen-lattice diffusion at high stresses. For $MgAl_2O_4$, the densification kinetics indicate nonlinear deformation with extrinsic oxygen-lattice diffusion as the rate-controlling mechanism. Four new and unique deformation (densification)-mechanism maps were developed in order to demonstrate deformation effects; these include two dimensional maps in grain size-temperature space and in stress-grain size space, two dimensional maps in stress-temperature space with contours of constant effective stress exponent, and finally, three-dimensional densification maps. (auth)

3464 (LBL—3957) **Kinetics and mechanisms of single phase solid state sintering.** Wong, B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 171p. Dep. NTIS $7.75.

Thesis.

Both theoretical and experimental studies of kinetics and mechanisms of single phase solid state sintering are presented. In general, kinetic and microstructural data satisfactorily support the proposed theoretical concepts. Sintering kinetic models based on rate controlling mass transport mechanisms, unified macroscopic viscous flow, and microscopic vacancy diffusion concepts were used to develop equations for both the intermediate and final stages of sintering. Experimental sintering studies on both undoped and CaO doped MgO powder compacts in static air and flowing water vapor atmospheres were performed in a temperature range between 1280 and 1600°C. Corresponding microstructural changes of sintered specimens during sintering were examined with a scanning electron microscope. Sintering kinetic data obtained were subsequently analyzed in terms of the appropriate proposed models; mechanisms of the sintering process under different experimental conditions were thus determined. (auth)

3465 Fabrication of REFEL silicon carbide components by isostatic pressing. Forrest, C.W.; Kennedy, P. (United Kingdom Atomic Energy Authority Reactor Group, Springfields). pp 183-184 of In Proceedings of the sixth symposium on special ceramics. Popper, P. (ed.). Stoke-on-Trent, Eng.; British Ceramic Research Association (1975).

From 6. symposium on special ceramics; Stoke-on-Trent, England (9 Jul 1974).

Isostatic pressing of silicon carbide powders was developed to produce large tubular components and slabs which cannot be readily extruded. Irregularly shaped components can either be pressed directly or pressed and machined in the green condition so that on firing, little or no machining is required. The powder used has a compaction ratio of about 2:1 and on pressing at 100 MN/m^2 and debonding, a density of 1970 kg/m^3 was obtained. The final density after siliciding was 3120 kg/m^3 corresponding to a composition of 87.5 vol percent SiC and 12.5 vol percent Si. The mean strength obtained by three-point bend tests is 446 MN/n^2 and Young's modulus is 404 GN/m^2. (UK)

3466 Role of boron and carbon in the sintering of silicon carbide. Prochazka, S. (General Electric Co., Schenectady, NY). pp 171-180 of In Proceedings of the sixth symposium on special ceramics. Popper, P. (ed.). Stoke-on-Trent, Eng.; British Ceramic Research Association (1975).

From 6. symposium on special ceramics; Stoke-on-Trent, England (9 Jul 1974).

The absence of densification on sintering of pure SiC is the result of its high grain boundary-to-surface energy ratio. Whenever this ratio exceeds a certain critical value, a solid will fail to densify without external pressure as there is not enough energy available to form the grain boundaries. Small additions of boron and carbon to submicron β-SiC powders having very low oxygen contents bring about normal sintering behaviour; densities above 98 percent of the theoretical are obtained on firing compacts at 2040°C in inert atmospheres. This observation is explained in terms of the effect of the additions on the above ratio: boron decreases the grain-boundary energy due to selective segregation while carbon increases surface energy due to deoxidation of the surface and removal of free silicon. (auth)

3467 Boron nitride composites by chemical vapor deposition. Pierson, H.O. (Sandia Labs., Albuquerque, NM). *J. Compos. Mater.;* **9**: 228-240(Jul 1975).

Composites of boron nitride (BN) have been made by the chemical vapor deposition (CVD) of a BN matrix on a BN felt fiber substrate. Reactant gases were boron trifluoride and ammonia. The composites have a relatively high density (1.70 g/cm^3), a crystallite size L/sub C/ = 150 A and an interlayer spacing d_{002} = 3.35 A. Measurements of elastic modulus and thermal conductivity and expansion showed some anisotropy as a result of the preferred fiber orientation of the substrate. (auth)

STRUCTURE AND PHASE STUDIES

3468 Vaporization behavior of hypostoichiometric U—Pu—O and U—Nd—O solid solutions. Tetenbaum, M. (Argonne National Lab., IL). pp 305-320 of In Thermodynamics of nuclear materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.2); CONF-741030—P2.

Oxygen potentials over the U—Pu—O system, where Pu/(U + Pu) = 0.2, have been established over the temperature range 2150 to 2550°K by means of a transpiration technique. These data are of particular importance since no data for the U—Pu—O system were previously available for this temperature range. The experimental oxygen potentials are approximately 10 to 15 kcal more positive than the previously accepted values obtained by extrapolation of lower temperature galvanic cell measurements. Values for the relative partial molar enthalpies and entropies of solution of oxygen are presented. Values of the partial pressure of actinide-bearing species have been calculated as functions of temperature and O/M ratio. Oxygen potentials for the U—Nd—O system, where Nd/(U + Nd) = 0.1 and 0.2, are higher than those obtained with unalloyed urania, but lower than those indicated for the U—Pu—O system. The introduction of neodymium into the fluorite lattice appears to have a strong effect on the magnitude of the partial molar entropy and enthalpy of solution of oxygen. X-ray analysis of several U—Nd—O compositions showed only a single face-centered-cubic structure and a decrease in lattice parameter with increasing oxygen content. (auth)

3469 High-temperature vaporization and mass spectrometric measurement of the extent of nonstoichiometry in oxide phases. Gilles, P.W.; Conard, B.R.; Sheldon, R.I.; Bennett, J.E. (Univ. of Kansas, Lawrence). pp 499-504 of In Thermodynamics of nuclear materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.2); CONF-741030—P2.

A new method has been devised for establishing the compositions of the lower phase boundary, the congruently vaporizing solution, and the upper phase boundary for high-temperature nonstoichiometric phases having significant ranges of homogeneity. The measurements are made at high temperature rather than on quenched samples. A two-phase sample of known composition is used. One of the phases is the non-stoichiometric one containing the particular composition at which congruent vaporization occurs; the other is the adjacent higher or lower phase. A weighed quantity is vaporized at constant temperature in a mass spectrometer until the congruently vaporizing state has been reached. The intensities of ions are measured during the entire experiment. The loss in mass, the initial composition, the intensities, and the times are used to obtain for the non-stoichiometric phase the compositions of the phase boundary and of the congruently vaporizing solution. The experiment is repeated with another sample whose initial composition is on the other side of the non-stoichiometric phase. The method is illustrated with results for the titanium—oxygen system in which the Ti_3O_5 phase contains the congruently vaporizing solution. (auth)

3470 Study of the 123-K phase transition of magnetite by critical neutron scattering. Fujii, Y. (Brookhaven National Lab., Upton, NY); Shirane, G.; Yamada, Y. *Phys. Rev., B;* **11**: No. 5, 2036-2041(1 Mar 1975).

A neutron-scattering study has been carried out on magnetite at temperatures just above the Verwey transition point of T/sub v/ = 123°K. No critical scattering was observed at the (0,0,2) reciprocal-lattice point where the magnetic scattering appeared below T/sub v/ due to the Verwey ordering as previously reported by Hamilton. On the other hand, well-defined critical scattering was observed at the points corresponding to the (4,0,1/2)-type satellites which has been found to result mainly from atomic displacements by Samuelsen et al. [J. Appl. Phys., 39: 1114(1968)]. These results indicate that atomic displacements due to internal lattice modes play an important part in the critical fluctuation of this phase transition. The intensity calculated on the basis of Δ_5 phonon mode with the wave vector of vector k = (0,0,1/2) qualitatively explains the observed intensity distribution of the critical scattering. The mode of the charge-density fluctuation on the octahedral Fe sites which couples with this phonon mode is quite different from the scheme of the well-known Verwey ordering. (auth)

3471 Electronic structure and fermi-surface-related instabilities in 1T-TaS_2 and 1T-$TaSe_2$. Myron, H.W. (Northwestern Univ., Evanston, IL); Freeman, A.J. *Phys. Rev., B;* **11**: No. 8, 2735-2739(15 Apr 1975).

The electronic-energy-band structure and full-Brillouin-zone Fermi surfaces of the layered dichalcogenides, 1T-TaS_2 and 1T-$TaSe_2$, have been calculated using the Korringa-Kohn-Rostoker method in the muffin-tin approximation. It is found that the Fermi surfaces for both systems away from symmetry points and lines have cross sections which are approximately constant along the z direction. Strong nesting features of the Fermi surface are found for a spanning vector parallel to the ΓM direction in reciprocal space with values in good agreement with the charge-density-wave results found by Wilson, Di Salvo, and Mahajan for these compounds. (auth)

3472 Cluster—Bethe-lattice method: the electronic density of states of heteropolar systems. Yndurain, F.; Joannopoulos, J.D. (Univ. of California, Berkeley). *Phys. Rev., B;* **11**: No. 8, 2957-2964(15 Apr 1975).

The cluster-Bethe-lattice method is extended to the study of heteropolar systems. The Bethe lattice is solved for binary compounds of arbitrary coordination using simple tight-binding models. In particular systems with tetrahedral coordination, such as the zinc-blende, BC-8 and random-network structures are examined in detail. The results are compared with recent experimental photoemission data on the amorphous phases of binary compounds and interpreted in terms of topology. (auth)

3473 Shell-model calculation of some point-defect properties in α—Al_2O_3. Dienes, G.J. (Brookhaven National Lab., Upton, NY); Welch, D.O.; Fischer, C.R.; Hatcher, R.D.; Lazareth, O.; Samberg, M. *Phys. Rev., B;* **11**: No. 8, 3060-3070(15 Apr 1975).

A polarizable point-ion shell model has been developed for α-Al_2O_3. The material is treated as perfectly ionic, the repulsive interactions were calculated from free-ion wave functions, and the single empirical parameter of the model was obtained from an analysis of dielectric data. The model yields a good account of the cohesive properties of the perfect crystal. Calculations of the formation energy of vacancies and interstitials predict that Schottky defects are energetically more favorable than Frenkel pairs. Preliminary calculations of defect motion energies suggest that O^{2-} vacancies are the most mobile defect. Existing data on diffusion and radiation-damage annealing are reviewed in light of the calculations. (auth)

3474 Soft-x-ray emission and absorption in diamond. Lubinsky, A.R. (Northwestern Univ., Evanston, IL); Ellis, D.E.; Painter, G.S. *Phys. Rev., B;* **11**: No. 8, 3131-3138(15 Apr 1975).

The x-ray K-emission spectrum and the soft-x-ray absorption spectrum are calculated for diamond and compared with experiment. The influence of transition matrix elements, calculated in a one-electron approximation, is discussed. Binding-energy corrections on the core and valence states are estimated and used to explain observed shifts between band transition energies and experimental data. Approximate methods are used to study localized valence relaxation effects on the transition matrix elements in emission. (auth)

3475 Pressure-induced phase transition in β-eucryptite ($LiAlSiO_4$) Morosin, B.; Peercy, P.S. (Sandia Labs., Albuquerque, NM). *Phys. Lett.;* **53A**: No. 2, 147-148(2 Jun 1975).

A pressure-induced phase transition was found in β-eucryptite using single crystal x-ray and Raman scattering measurements. The high pressure phase forms at a pressure of ~8 kbar at 300°K, is metastable at 1 bar and will revert to the normal low pressure phase with time at this temperature. (auth)

3476 Electron paramagnetic resonance of divalent thallium in cadmium telluride. DuVarney, R.C.; Garrison, A.K. (Emory Univ., Atlanta). *Phys. Rev., B;* **12**: No. 1, 10-14(1 Jul 1975).

An analysis of EPR spectra from CdTe:Tl single crystals shows that Tl^{2+} goes into the CdTe lattice as a substitutional impurity at a cadmium site. The unpaired s electron on the thallium ion has an isotropic hyperfine interaction of 53.3 +- 0.3 and 53.7 +- 0.3 GHz with the ^{203}Tl and ^{205}Tl isotopes, respectively, and a g factor of -2.035 +- 0.015. The sign of the hyperfine-interaction constant is inferred to be positive from the temperature dependence of the line intensities and the negative sign of the g factor is assumed. A superhyperfine (shf) interaction with the nearest-neighbor tellurium ligand ions is observed whenever the sites are occupied by the 7 percent abundant ^{125}Te nucleus. The shf-interaction tensor is axially symmetric about the bond direction with parallel A/sub parallel/parallel = 375 +- 5 G and parallel A /sub perpendicular to/parallel = 180 +- 5 G. (auth)

3477 Structure and order parameters in the pressure-induced continuous transition in TeO_2. Worlton, T.G.; Beyerlein, R.A. (Argonne National Lab., IL). *Phys. Rev., B;* **5**: No. 5, 1899-1907(1 Sep 1975).

Lattice parameters of TeO_2 were measured from 0 to 32.5 kbar by time-of-flight neutron diffraction. Atomic-position parameters were also measured to 20 kbar for both the low-pressure tetragonal paratellurite phase and the high-pressure orthorhombic phase, which we determined to have a structure belonging to the $D^4_8(P2_12b812)$ space group. No hystersis was found in the lattice parameters or position parameters in cycling through the transition. It was also found that $(b-a^2)/a_0^2$ in the high-pressure phase varied linearly with pressure with a slope of $2.53(1) \times 10^{-4}$ kbar, going to zero at 9.1 kbar. No discontinuity was detected in volume or the c parameter, but anomalies were observed in the slopes dV/dP, d(a + b)/dP, and dc/dP. All of these observations are additional experimental evidence for the continuous nature of the transition. The observed D_2^4 structure of the high-pressure phase is a subgroup of order 2 of the D_4^4 paratellurite phase which means that the free energy is an even function of the order parameter, but third-order terms coupling the primary order parameter with secondary or induced order parameters can still be formed. These can be nonzero without affecting the second-order nature of the transition. The primary order parameter $eta_1 = e_1-e_2$ and the two induced order parameters which were observed, $eta_2 = e_1+e_2$ and $eta_3 = e_3$, were used to derive a Landau-like free-energy expansion describing the thermodynamics of the transition.Very little displacement of the Te atoms was observed in going through the transition, but the oxygen atoms underwent large displacements as a function of pressure. There is no change of size of the unit cell at the transition so it is a pure strain transition of the type first discussed by Anderson and Blount. (auth)

MECHANICAL PROPERTIES

3478 (CONF-751101—16) **Steady-state creep model for UO_2.** Olsen, C.S. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 5p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

From a review of out-of-pile and in-pile experiments, an analytical model was developed for the steady-state creep of UO_2: epsilon = $[(A_1 - A_2F)$sigma e/sup $-Q_1/RT/]/[A_3 + D)G^2] + [A_4$sigma/sup 4.5/e/sup $-Q_2/RT/]/[(A_5 + D)] + A_6$sigma Fe/sub$Q_3/RT/$, where $A_1 = 9.728 \times 10^6$, $A_2 = 3.24 \times 10^{-12}$, $A_3 = -87.7$, $A_4 = 1.376 \times 10^{-4}$, $A_5 = -90.5$, $A_6 = 9.24 \times 10^{-28}$, $Q_1 = 90{,}000$, $Q_2 = 132{,}000$, $Q_3 = 5200$ (cal/mole), F = fission rate (8.4×10^{17} to 1.18×10^{20} f/m²s), and G = grain size. (DLC)

3479 **Compressive creep of hypostoichiometric UO_2 and $(U,Pu)O_2$ nuclear fuel pellets.** Javed, N.A. (Pakistan Inst. of Nuclear Science and Tech., Rawalpindi). pp 435-446 of In Thermodynamics of nuclear materials, 1974. Volume I. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.1); CONF-741030—P1.

The steady-state compressive creep rates of UO/sub 2-x/ and $(U_{0.75}Pu_{0.25})$O/sub 2-x/ fuel pellets were measured as a function of temperature (1400 to 1700°C), stress (1—12) x 10^3 lbf/in², and oxygen-to-metal ratio (2.000 to 1.975 for urania and 1.985 to 1.903 for the mixed oxide). The density and grain size for the two types of oxide pellets were similar, i.e., 95 percent TD and 10 to 13 μm, respectively. The dependence of creep, for a fixed O/M ratio, on stress and absolute temperature may be described by the linear superposition of a viscous flow and power-law creep relation. Inasmuch as the effect of O/M ratio was concerned, for UO/sub 2-x/ at 1700°C, the creep rate decreased with the decrease of O/M ratio in the range of oxygen-to-uranium ratios of 1.975 to 2.000. The effect of O/M ratio on creep rates in the linear-stress as well as in the power-law regions was the same. The apparent activation energy in the linear-stress region was calculated to be 81 +- 3 kcal/mol for UO_{2-000} and 118 +- 4 kcal/ mol for $UO_{1.975}$. In the case of mixed-oxide fuel pellets, at 1550°C the creep rates increased with decreasing O/M ratio from 1.985 to 1.903. The apparent activation energies in the low-stress region for an O/M ratio of 1.985 was 128 +- 6 kcal/mol and 73 +- 5 kcal/mol for an O/M ratio of 1.903. The creep behavior of the two oxides has been explained on the basis of a cation diffusion model. (auth)

3480 **Tensile and bend strengths of silicon nitride and hot-pressed silicon carbide.** Ashcroft, W. (National Gas Turbine Establishment, Farnsborough, Eng.). pp 245-259 of In Proceedings of the sixth symposium on special ceramics. Popper, P. (ed.). Stoke-on-Trent, Eng.; British Ceramic Research Association (1975).

From 6. symposium on special ceramics; Stoke-on-Trent, England (9 Jul 1974).

Short-term strength of a number of batches of hot-pressed silicon nitride, a reaction-bonded silicon nitride, and hot-pressed silicon carbide is measured. The bend strengths of these materials in air up to 1450°C are compared in relation to some aspects of structure and composition. Differences in strength levels and strength variability exist between some batches of hot-pressed silicon nitride at different temperatures. These are discussed in relation to the type of impurities present. Tensile testing of ceramics at high temperatures is necessary to complement bend strength values, particularly when nonelastic deformation occurs. A new design of tensile test apparatus that operates in air to high temperatures has been developed and used for short-term strength measurements on hot-pressed silicon nitride. Initial results are compared with bend strengths of similar materials in terms of the Weibull analysis concept of equivalent volumes. (auth)

3481 **Thermal shock behaviour of sintered carbide and reaction-bonded silicon nitride.** Weaver, C.O.; Baumgartner, H.R.; Torti, M.L. (Norton Co., Worcester, MA). pp 261-278 of In Proceedings of the sixth symposium on special ceramics. Popper, P. (ed.). Stoke-on-Trent, Eng.; British Ceramic Research Association (1975).

From 6. symposium on special ceramics; Stoke-on-Trent, England (9 Jul 1974).

The thermal shock behaviour of five sintered silicon carbides and two sintered silicon nitrides was investigated by quenching from elevated temperatures into a room-temperature water bath. The onset of thermal shock damage was detected by increases in specific damping capacity and decreases in strength. The ΔT necessary to initiate damage was correlated with R′, the theoretical parameter relating mechanical properties to the resistance to crack initiation caused by rapid thermal quenching. (auth)

PHYSICAL PROPERTIES

3482 (CALT—822-76) **Low-temperature resistivity of amorphous iron—phosphorus alloys.** Logan, J.; Yung, M. (California Inst. of Tech., Pasadena (USA). W.M. Keck Lab. of Engineering Materials). Sep 1975. Contract AT(04-3)-822. 9p. Dep. NTIS $4.00.

Results of electric conductivity measurements on Fe—P alloys at 4 to 80°K are presented in plots of temperature vs conductivity and composition vs conductivity. (JRD)

3483 (CONF-750507—1) **Luminescence in deformed alkaline-earth oxides.** Chen, Y.; Abraham, M.M.; Turner, T.J.; Nelson, C.M. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.00.

From Oxide symposium; Chapel Hill, North Carolina, USA (26 May 1975).

Plastic deformation of the alkaline-earth oxides gives rise to optical absorption bands, the most pronounced of which occur at 5.7 eV in MgO, 4.6 and ~5.8 eV in CaO, and 4.1 and ~5.0 eV in SrO. Excitations in these energy regions generate emission bands, with peaks that occur at 2.9 (violet), 2.6 (blue), and 2.3 eV (green) in MgO, CaO and SrO, respectively. The absorption and emission spectra of a deformed CaO crystal are given. The temperature and anisotropy dependence of the emission spectra from 5 to 295°K give clear indications that multi-bands are involved. (auth)

3484 (SAND—74-7013) **Charge transport and storage in SiO_2.** Hughes, R.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 35p. (CONF-750983—1). Dep. NTIS $4.75.

From International symposium on electrets and dielectrics; Sao Carlos, Brazil (1 Sep 1975).

The present state of knowledge on the generation, transport, and trapping of excess electrons and holes in a-SiO_2 is reviewed. It is noted that the charge carrier phenomena observed in a-SiO_2 are, in many ways, different from the well characterized nonpolar semiconductors. Despite the relatively free nature of the electron, strong coupling with the polar lattice modes keeps the mean-free path fairly short at room temperature and leads to very high avalanche fields and field dependence of yield of electron-hole pairs for all kinds of bulk excitation. In contrast the hole transport is dominated by the disorder and defect structure which can be modified by processing steps in the growth of the oxide. A number of unsolved problems remain. (auth)

3485 (ANL-Trans—987) **Properties of liquid alumina.** Elyutin, V.P.; Mitin, B.C.; Nagibin, Yu.A. Translated from *Fiz. Aerodispersnykh Sist.*; No. 7, 104-109(1972). 8p. Dep. NTIS $4.00.

The density, surface tension, and viscosity of liquid alumina were determined at temperatures up to 2800°K. The tests were performed in a vacuum not higher than 10^{-4} mm Hg and in a purified argon atmosphere. Results show that alumina dissociates into

ions during melting. The dependence of liquid Al_2O_3 density on temperature is expressed by $\gamma = 3.01 - 1.15 \times 10^{-3}$ (T - 2305°K). The temperature dependence of the surface tension of liquid alumina is expressed analytically by the formula: delta = 660 - 0.195 (T - 2305°K). The values for viscosity of liquid Al_2O_3 are tabulated and shown graphically. (JRD)

3486 Transport processes in composite media. Davis, H.T. (Univ. of Minnesota, Minneapolis); Valencourt, L.R.; Johnson, C.E. *J. Am. Ceram. Soc.;* **58**: No. 9-10, 446-452(1975).

From Joint fall meeting of the Basic Science and Nuclear Divisions of the American Nuclear Society; Williamsburg, VA, USA (1 Oct 1974).

Transport processes in two types of composite media were investigated. In one type, exemplified by hydrogen diffusion in steel with microvoids present, short-lived trapping reactions result in a lowering of the effective or overall diffusion coefficient. The other type of composite consists of randomly mixed parts or phases having no interfacial resistance or trapping. The percolation properties of such systems are reviewed, and thermal conductivity, self-diffusivity, and gas permeability in certain porous solids are analyzed in the light of percolation theory. (auth)

3487 Measurement of surface-plasmon dispersion in oxidized aluminum films. Pettit, R.B.; Silcox, J.; Vincent, R. (Cornell Univ., Ithaca, NY). *Phys. Rev., B;* **11**: No. 8, 3116-3123(15 Apr 1975).

A 75-keV electron beam with a low angular divergence (8 x 10^{-4} rad) combined with a Wien filter spectrometer is used to measure the dispersion of the ω^+ and ω^- modes for surface plasmons in thin oxidized aluminum films. The results for normal incidence and for tilted films are self-consistent and are also in reasonable agreement with theoretical curves calculated for a 35- to 40-A oxide layer, provided reasonable assumptions are made about the composition and dielectric constants of the aluminum oxide. (auth)

3488 Energy bands, electronic properties, and magnetic ordering of CrB_2. Liu, S.H. (Ames Lab., IA); Kopp, L.; England, W.B.; Myron, H.W. *Phys. Rev., B;* **11**: No. 9, 3463-3468(1 May 1975).

Energy bands of CrB_2 were calculated using the Korringa—Kohn—Rostoker method in the muffin-tin-potential approximation. The bands near the Fermi level have mostly Cr d character, and one of the bands gives rise to a very flat piece of Fermi surface perpendicular to the hexagonal axis. It is proposed that this piece of Fermi surface stabilizes a spin-density-wave state which manifests itself as antiferromagnetic ordering of the compound below 85°K. The excess specific heat and electronic-spin susceptibility is also interpreted as due to exchange enhancement. (9 figures) (auth)

3489 Exchange-split crystal-field levels of Fe^{2+} in $FeCO_3$. Lynn, J.W.; Mook, H.A.; Buyers, W.J.L. (Oak Ridge National Lab., TN). *Phys. Rev., B;* **12**: No. 1, 238-242(1 Jul 1975).

Neutron time-of-flight measurements of the low-lying crystal-field excitations were taken on both a natural single crystal and pure synthetic powder of $FeCO_3$ above and below the Neel temperature (T/sub N/ = 38.4°K). At 4.2°K the principal allowed excitation was measured to be 13.75 +- 0.10 meV, in good agreement with previous neutron and far-infrared measurements. A second less intense excitation was observed at 19.75 +- 0.25 meV. Above T/sub N/ a broadened excitation at 11.2 meV was observed, with a small shoulder persisting on the high-energy side. The measured excitation energies and transition probabilities can be adequately described by a single-ion Hamiltonian which includes spin-orbit coupling, trigonal distortion, and an Ising molecular field, taken in the lowest-lying cubic-crystal-field state of Fe^{2+}. (auth)

3490 Percolative conduction in semiconducting liquid selenium—thallium mixtures. Pettit, R.B.; Camp, W.J. (Sandia Lab., Albuquerque, NM). *Phys. Rev. Lett.;* **35**: No. 3, 182-185(21 Jul 1975).

Measurements of the electrical conductivity of the semiconducting liquid Tl/sub x/Se/sub 1-x/ are reported over the temperature range 250 less than or approximately equal to T less than or approximately equal to 500°C, and the composition range 0.002 less than or equal to 0.377 (as well as x = 0). The conductivity is thermally activated for all temperatures and compositions studied and its behavior is consistent with a changeover in conduction mechanism as x increases from zero. The x > 0 results are interpreted in terms of percolative hopping. (auth)

3491 Pressure measurements very near an electrical arc discharge in a liquid using a lithium niobate piezoelectric transducer. Huff, C.F.; Graham, R.A. (Sandia Labs., Albuquerque, NM). *Appl. Phys. Lett.;* **27**: No. 4, 163-164(15 Aug 1975).

The pressure pulse generated by an electric arc discharge in aqueous liquids was measured using a lithium niobate piezoelectric transducer. These measurements are the first time-resolved pressure pulses recorded in proximity to an arc channel. (auth)

3492 Cherenkov pulse dispersion in two low-loss fibers. Franks, L.A.; Nelson, M.A.; Davies, T.J. (EG and G, Inc., Goleta, CA). *Appl. Phys. Lett.;* **27**: No. 4, 205-207(15 Aug 1975).

The material and mode dispersion of a 50-ps Cherenkov light pulse generated in 500-m lengths of low-loss graded and step-index Corning fibers was measured. The initial 15.7-ns full width at half-maximum (FWHM) transmitted pulse in the graded fiber was reduced to less than 2 ns with narrow-band optical filtering. Parallel measurements in the step-index fiber gave a value of less than 4 ns for an initial 16.3-ns FWHM pulse. Fluorescence induced in the fiber by the electron radiation was less than 1 percent of the amplitude of the transmitted Cherenkov light in the graded fiber and approximately 2 percent in the step fiber. (auth)

3493 Hot electron in SiO_2. Hughes, R.C. (Sandia Lab., Albuquerque, NM). *Phys. Rev. Lett.;* **35**: No. 7, 449-459(18 Aug 1975).

The experimentally determined drift velocity of excess electrons in α-SiO_2 as a function of field is reported. Saturation of the velocity-field curve above 10^7 cm/s provides evidence for phonon emission by significantly heated electrons. The data provide the first test of, and good agreement with, the Thornber and Feynman theory of electron energy loss in polar materials at high applied fields.

3494 Photoluminescence in high-resistivity CdTe:In. Barnes, C.E. (Sandia Labs., Albuquerque, NM). *J. Appl. Phys.;* **46**: No. 9, 3959-3964(Sep 1975).

Photoluminescence measurements have been performed at 4.2°K between 1.2 and 1.6 eV on compensated high-resistivity CdTe containing from 10^{15} to 10^{18} cm^{-3} indium. A series of phonon-coupled emission bands with a no-phonon peak at 1.454 eV is dominant in most samples and grows in intensity with increasing In concentration. On the basis of the compensation model, the 1.454-eV emission is attributed to radiative recombination at an [cadmium vacancy-In] acceptor complex. Comparisons of the experimental results with this model suggests that the chemical equilibria governing formation of the acceptor complex are frozen in at approximately 500°K as the sample is cooled from the growth temperature. The existence of significant changes at 500°K in the mobility of defects related to the acceptor complex is confirmed by the observation of a prominent growth in the 1.454-eV emission at an annealing temperature of 500°K in A^+-implanted n-type CdTe. Exciton emission in the CdTe:In samples is dominated by a narrow bound exciton band at 1.584 eV which is assigned to recombination at a center associated with In. Edge emission is relatively weak in all samples with the peak positions varyng from 1.538 to 1.546 eV. (auth)

3495 Kinetic effects in the electrical response of a shock-compressed ferroelectric ceramic. Lysne, P.C. (Sandia Labs., Albuquerque NM). *J. Appl. Phys.;* **46**: No. 9, 4078-4079(Sep 1975).

Projectile impact experiments were conducted on specimens of PSZT 70/30-6. The shock-wave-induced depolarization of this material has an equilibration time of ≈0.2 μs which is similar to that of other ferroelectric ceramics. However, PSZT 70/30-6 does not revert rapidly to a poled state upon unloading. Thus, a nearly constant voltage is produced in axial-mode experiments even though shock and release waves reverberate within the specimens. This response of PSZT 70/30-6 is likely caused by a phase transformation near 0.3 GPa. (auth)

3496 Heat capacity of sapphire between 2 and 10 K by ac technique. Viswanathan, R. (Brookhaven National Lab., Upton NY). *J. Appl. Phys.;* **46**: No. 9, 4086-4087(Sep 1975).

The low-temperature heat-capacity data of small single crystals of sapphire obtained by an ac calorimetric technique are reported. The lattice heat-capacity coefficient β is calculated to be 0.00172 mJ/g atom K, giving a Debye temperature theta/sub D/ of 1042°K. This is in very good agreement with the published theta/sub D/ of 1035°K, on samples which were ~1000 times larger. (auth)

3497 Low-temperature heat capacity of $CrH_{0.97}$. Viswanathan, R. (Brookhaven National Lab., Upton NY); Khan, H.R.; Knoedlr, A.; Raub, Ch.J. *J. Appl. Phys.;* **46**: No. 9, 4088-4089(Sep 1975).

Reported here are the low-temperature (1.7 to 10°K) heat-capacity data of a CrH/sub 0.97/ sample prepared by an electrochemical method. The electronic heat-capacity coefficient γ and the Debye temperature theta/sub D/ are found to be 4.5 mJ/g mole K^2 and 360°K, respectively. These results are compared with the available literature data. (auth)

3498 Moessbauer study of Yb spin reorientation and low-temperature magnetic configuration in $YbFeO_3$. Davidson, G.R. (Argonne National Lab., IL); Dunlap, B.D.; Eibshuetz, M.; van Uitert, L.G. *Phys. Rev., B;* **12**: No. 5, 1681-1688(1 Sep 1975).

The spin-reorientation transition of $YbFeO_3$ was observed and the magnetic configuration below this transition characterized. The magnitudes and directions of the Yb^{3+} magnetic moments were measured between 4.2 and 10°K using the ^{170}Yb Moessbauer resonance and single-crystal absorbers. The spectra are consistent with the occurrence of a continuous rotation of the Yb spins over the temperature interval 6.55 less than or equal to T less than or equal to 7.83°K found in a previous specific-heat experiment. Results agree with qualitative predictions by Horner and Varma and by Yamaguchi, but the quantitative predictions of Yamaguchi are found not to apply to $YbFeO_3$. Comparison with bulk magnetization data establishes that the net Yb and Fe magnetic moments rotate in opposite directions during the reorientation. At 4.2°K, the Yb spins are at an angle 27.2° (or 180°-27.2) +- 1.4° with the a axis, and the Fe spins have a canting angle of 1.7° +- 0.6°, three times the value for the T greater than or equal to 85°K. In addition, the orientations of the principal axes of the electric field gradient at the Yb nucleus were determined. (auth)

COMPOSITE MATERIALS

MECHANICAL PROPERTIES

3499 (COO—1794-25) **Strength and fracture properties of random fiber polyester composites.** Gaggar, S.K.; Broutman, L.J. (Illinois Inst. of Tech., Chicago (USA)). Feb 1975. 36p. (CONF-750201—2). Dep. NTIS $5.00.

From 30. anniversary reinforced plastics tech. management conference; Washington, District of Columbia, USA (5 Feb 1975).

The random arrangement of glass fibers in resin matrices produces composite materials which have planar isotropy and are of great importance to many structural and engineering applications. Random fiber composites offer a good combination of mechanical properties and are thus extensively used in various industries. This study deals with the characterization of strength and fracture behavior of random glass fiber reinforced polyester composites. The concepts of Linear Elastic Fracture Mechanics (LEFM) were applied to these composites to obtain meaningful toughness parameters. It is shown that a substantial amount of slow crack growth occurs prior to unstable fracture and thus the total fracture behavior of the material should be studied by applying the concepts of Crack Growth Resistance Curves (R-Curves). These curves can then be used to determine the value of candidate stress intensity factor, K/sub Q/, and the point of crack instability. Notch Bend Fracture Tests were performed to estimate the total fracture energy for the material. It is shown that the debonding energy mechanism is dominant in these materials and the total fracture energy can be predicted by considering the energy absorbed in the debonding and the pull out process.

3500 Tensile properties of PRD-49 fiber in epoxy matrix. Chiao, T.T.; Moore, R.L. (Univ. of California, Livermore). *J. Compos. Mater.;* **6**: 547-551(Oct 1972).

Recently a high-modulus and high-strength organic fiber, identified as PRD-49-III by the manufacturer, became commercially available. The tensile properties of the fiber in an epoxy matrix were determined. Over 6000 fiber/epoxy strands were made using the filament winding process; these strands were representative samples taken from over 60 lb of single-end fiber. Emphasis was placed on the fiber uniformity, its strength distribution at room and LN2 temperature, stress-strain characteristics, and the strain rate effect on the fiber strength. (auth)

3501 (UCRL-Trans—10938(Pt.1-2)) **Methods for nondestructive testing of composite materials.** Buhmann, K.P.; Stelling, H.A.; Winkler, T. Translated from *Kunststoffe;* **64**: No. 12, 750-762(1974). 50p. Dep. NTIS $5.00.

Nondestructive testing has become increasingly important recently for quality assurance and quality control in regard to the proof of required material properties and irregularities which occur in plastics also, especially composite materials. Nondestructive techniques are discussed which have given satisfactory results for a long time in metal testing, and also newer techniques often used for composite materials. The further development of these methods and their value are illustrated by examples. (31 references, 23 figures) (auth)

3502 Influence of the interface on the fracture toughness of low aspect ratio fibre composites. Mallick, P.J.; Broutman, L.J. (Illinois Inst. of Tech., Chicago). *Fibre Sci. Technol.;* No. 8, 113-144(1975).

The fracture toughness of an epoxy resin reinforced with discontinuous glass fibers of low fiber aspect ratios was measured by double cantilever cleavage tests and notched bend tests. The fiber—matrix interfacial adhesion was varied by applying different surface treatments to the fibers. It was observed that the interfacial bond strength determines whether the crack initiates by debonding at the fiber—matrix interface or by fiber failure and also the relative values of the energies absorbed during these processes. The interfacial bond strength also controls the energy absorbed due to fiber pull-out. When all these energies are accounted for, it is shown that a weak interfacial bond may produce a composite with a fracture toughness higher than that which can be obtained by strong interfacial bonds. (auth)

3503 Mechanical and fracture behavior of glass bead filled epoxy composites. Mallick, P.K.; Broutman, L.J. (Illinois Inst. of Tech., Chicago). *Mater. Sci. Eng.;* **18**: 63-73(1975).

The strength and fracture properties of glass bead filled epoxy composites were examined using fracture mechanics approach. It was shown that the critical crack size which controls the strength of such composites is not influenced by the interparticle distance as suggested by Hasselman and Fulrath. Also, since the crack size cannot be controlled by crack-dispersed particle interaction, a strength value higher than the matrix strength is not expected. (auth)

PHYSICAL PROPERTIES

3504 Electronic contribution to the c-axis elastic constants of hexagonal crystals. Green, J.F.; Spain, I.L. *Phys. Rev. Lett.;* **11**: No. 10, 3935-3943(15 May 1975).

The effect of c-axis elastic strain on the first Brillouin zone for hexagonal crystals is determined. The electronic contribution to c-axis elastic moduli is estimated for graphite, a semimetal, and boron nitride, an insulator, using the parabolic and other band models. It is found that a large contribution to the elastic constants can arise from the effect of strain on the electronic energy, arising from a redistribution of electrons within the strained Brillouin zone, or from changes in the bulk electronic properties. It is shown that experimental c-axis moduli for graphite can be described empirically if both ion-ion and electron band energies are considered. (7 fig, 29 references) (auth)

POLYMERS AND PLASTICS

PREPARATION AND FABRICATION

3505 (BDX—613-1414(Rev.)) **Molding characteristics of thermoplastic foams.** Walter, C.L. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 16p. Dep. NTIS $4.00.

Rheological and processing characteristics for three injection-moldable foam systems were evaluated. Two polycarbonates containing 6 percent glass fiber and a polyester containing 33 percent glass fiber were studied. Results indicate that foam parts having densities approximately 50 percent of the specific gravity of the base resins can be produced on existing injection molding equipment. (auth)

3506 (SAND—75-0411) **Composition and structure of a stress relieving removable epoxy resin.** Carter, C.V. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 59p. Dep. NTIS $5.50.

The aqueous modification of polyol modified anhydride cured diglycidyl ether of bisphenol A exhibits properties of a brittle solid when subjected to an impulse stress, and properties of a viscous fluid when subjected to a steady state stress. This behavior is markedly different from the nonaqueous system. Early attempts to understand the nature of the change in properties and the physical mechanism involved have not been completely successful. Previous studies of the aqueous modification of polyol modified anhydride cured diglycidyl ether of bisphenol A have verified that the water significantly accelerates the anhydride ring opening reaction compared to the nonaqueous system. It had been postulated that the accelerated ring opening reaction facilitated the formation of a noncrosslinked low molecular weight polymer. In an attempt to confirm this hypothesis, the elucidation of the structure was undertaken. High-speed gel permeation chromatography indicated two things: (1) the material is noncrosslinked because it dissolves in solvent, and (2) the highest molecular weight material formed is approximately 2500.The material was shown to be composed of eight components. The three smallest components are unreacted starting materials and only 4 percent of the overall system. The molecular weight range of the five remaining components is 500 to 2400, with 80 percent of the material being of an average molecu-

lar weight of 1900. The five remaining components have been identified by the use of infrared analysis, gas chromatography-mass spectrometry, and elemental analysis. Verification of the structures was accomplished via saponification of the products and identification of the fragments. (auth)

MECHANICAL PROPERTIES

3507 (SAND—75-0473) **Room temperature creep of Kevlar 49-epoxy composites.** Ericksen, R.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 26p. Dep. NTIS $4.00.

The creep of Kevlar 49-ERLA 4617 epoxy composites at room temperature was studied. The results were compared with creep behavior of individual fibers and unreinforced epoxy. Composites exhibited transient creep throughout the 1000-hour tests; no steady state creep was observed. The shape of the composite creep curves varied with stress. The changes were related to the creep behavior of fibers and matrix tested individually under conditions of strain comparable to those in the composite. At low stresses the matrix initially creeps at a slower rate than the fibers, whereas at higher stresses the reverse situation exists. The time-dependent redistribution of stress between constituents is compared with theoretical treatments for composite creep. (auth)

PHYSICAL PROPERTIES

3508 (UCRL—51885) **Equation of state of plastics: polystyrene and its foams.** Ree, F.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Aug 1975. Contract W-7405-Eng-48. 30p. Dep. NTIS $4.00.

New equation of state (EOS) data is presented for polystyrene, covering densities between 1 and 10^6 kg/m^3 and temperatures to 6000 eV. Different physical processes occurring at various ranges of densities and temperatures are discussed. The procedure used here is to combine several of the latest theoretical models which can describe these processes in order to generate EOS data over the entire density and temperature range described above. Comparison with experimental Hugoniots supports the general usefulness of such a procedure. Further improvements that can be made in the theoretical models are discussed. (auth)

OTHER MATERIALS

PREPARATION AND MANUFACTURE

3509 **Effect of NiO and $NiFe_2O_4$ dopants on the processing and properties of lithium ferrite spinel.** Bandyopadhyay, G.; Fulrath, R.M. (Univ. of California, Berkeley). *Am. Ceram. Soc. Bull.*; **54**: No. 5, 506-509(May 1975).

Polycrystalline compacts of lithium ferrite doped with controlled amounts of NiO and $NiFe_2O_4$ were sintered using a stoichiometric packing powder under one atmosphere oxygen pressure. Both dopants had only a slight effect on the densification. NiO favored discontinuous grain growth, whereas $NiFe_2O_4$ suppressed it. Dc resistivity was affected significantly by the addition of minute amounts of either of the two dopants. The coercive force decreased with addition of NiO, but increased with addition of $NiFe_2O_4$. (auth)

3510 (BDX—613-1454(Rev.)) **Surface preparation of Kapton for aluminum deposition.** Ulitchny, M.G. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 17p. Dep. NTIS $4.00.

General cleaning techniques, suitable to product application, for the preparation of Kapton (E.I. du pont de Nemours and Company) substrates to be coated with aluminum were evaluated. Surface cleaning methods evaluated included detergent and solvent cleaning, caustic etching, argon and oxygen sputter etching, and ultraviolet light-oxygen treatment. Adhesion strength of the 1 to 1.5 μm thick thermally evaporated aluminum deposits was measured by both tape-type peel tests and direct pull tests. Best adhesion occurred when the Kapton was cleaned in detergent and solvent, caustic etched for a short time, and ultraviolet light treated in a partial pressure of oxygen before aluminization. Adhesion values up to 7008 newtons for direct pull on samples of 645 mm^2 cross section were achieved with this cleaning technique. (auth)

3511 (BNL—20336) **Polymer-concrete composites for energy related systems. Progress report No. 5, April—June 1975.** (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 15p. Dep. NTIS $4.00.

Activities in research programs are reported on polymer—concrete materials for geothermal applications and in applications for solid nonradioactive waste incorporation in useful products. (JRD)

3512 (SRIA—37(Add.)) **Plasma-sprayed boron films and coatings: a feasibility study.** Farley, E.P.; Engelke, J.L. (Stanford Research Inst., Menlo Park, Calif. (USA)). 19 Jan 1962. 19p. (UCRL—13021(Add.)). Dep. NTIS $4.50.

Declassified 20 Oct 1971.

Results of work directed to production of B spheres are reported. The stockpile boron supplied by LRL was processed through the Institute's plasma spheroidizer in suitable particle-size fractions. Physical properties were altered in all sizes, although complete spheroidization of individual particles appeared only at 200 mesh (74 μ) and below. The products from the spheroidizer were characterized with respect to their particle size, sphere content, packing density, and surface area. An average sphere content of 50 to 60 percent (particle-count technique) was obtained for size fractions below 200 mesh. By mixing portions of the various particle-size products from initial tests to represent the composition of the bulk sample, packing densities as high as 1.54 g/cm^3 were achieved, but in the practical processing of the bulk sample, a final mixture with a packing density of 1.37 g/cm^3 was obtained. This was a 26.9 percent increase over the as-received material which had a density of 1.08 g/cm^3. This final mixture (400 g) was submitted to LRL. Surface area for the bulk material was reduced from 8.55 to 3.14 m^2/g. The flowability of the stockpile material was greatly improved, and with the parameters developed under the present program, a 30 percent increase in deposition efficiency can be expected in plasma-sprayed boron coatings as compared with the values obtained in the initial portion of this program. (auth)

STRUCTURE AND PHASE STUDIES

3513 (ITP—75-35R) **Alpha-oxygen doublet.** Gaididei, Yu.B.; Loktev, V.M.; Prikhot'ko, A.F.; Shanskii, L.I. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1975. 21p. (In Russian). Dep. NTIS (US Sales Only) $4.25.

A group-theoretical classification of bimolecular states of the α-O_2 crystal is presented. It is found that the lines of bimolecular absorption must be polarized. It is shown that, with allowance for the collective nature of excited states, the absorption lines split into doublets. The electron-vibrational structure of bimolecular transition bands is studied. (2 figures, 1 table) (auth)

3514 **Technique for measuring preferred orientation in pyrolytic-carbon coatings using plane-polarized light.** Bomar, E.S.; Gray, R.J.; Eatherly, W.P. (Oak Ridge National Lab., TN). pp 885-897 of In Microstructural science. Volume 3. French, P.M.; Gray, R.J.; McCall, J.L. (eds.). New York; American Elsevier Publishing Co., Inc. (1975).

The degree of preferred orientation of pyrolytic carbon can be inferred from the variation in intensity of plane-polarized light reflected from a rotating sample. A homogeneous array of crystallites at a reflecting plane shows a constant reflecting power as the sample is rotated, but if preferred orientation is present the intensity of the reflected light will vary due to bireflection of carbon crystallites. The amount of preferred orientation is expressed as an optical anisotropy factor (OPTAF), which is defined as the ratio of maximum-to-minimum intensity of the reflected light. The practical application of microphotometry is illustrated by measuring the OPTAF of two batches of pyrolytic-carbon-coated microspheres and comparing these measurements with their behavior on irradiation with fast neutrons. (auth)

3515 **Search for crystallographic instability in hexagonal tungsten bronzes.** Lawson, A.C. (Univ. of California, San Diego, La Jolla); Fisk, Z.; Shanks, H.R. *Phys. Rev. Lett.*; **11**: No. 10, 4054(15 May 1975).

X-ray powder diffraction at 6°K shows no evidence of crystallographic instability in $K_{0.3}WO_3$ and $Rb_{0.3}WO_3$. (auth)

3516 **Microscopic calculation of electromagnetic fields in refraction at a jellium-vacuum interface.** Feibelman, P.J. (Sandia Labs., Albuquerque, NM). *Phys. Rev., B;* **12**: No. 4, 1319-1336(15 Aug 1975).

For a long-wavelength electromagnetic wave of frequency ω, incident on a jellium-vacuum interface, the spatial dependence of the vector potential, vector A(vector r;ω), is evaluated in the surface region. A simple integral equation is derived which relates vector A(vector r;ω) to the jellium nonlocal conductivity tensor reversible sigma(vector r;vector r,ω);numerical calculations based on this equation are reported, in which the random-phase approximation to reversible sigma(vector r;vector r,ω) was used--the required single-electron wave functions were evaluated via the self-consistent surface-barrier potentials of Lang and Kohn. Families of graphs of vector A(vector r;ω) are presented, for fixed bulk electron concentration as a function of frequency and for fixed ω/sub p/ω (where ω/sub p/ is the plasma frequency) as a function of bulk electron concentration. The sensitivity of vector A(vector r;ω) to

the shape of the surface potential barrier, at fixed ω and bulk electron concentration, is also explored. The use of the results obtained for vector A(vector r;w) is proposed for the calculation of refraction effects in surface photoemission and in reflection spectroscopy. (auth)

PROPERTIES

3517 Temperature dependence of EPR linewidth in EuSe: field suppression of fluctuation scattering processes. Streit, P.; Kasuya, A.; Everett, G.E. (Univ. of California, Riverside). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 47-48(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The linewidth versus temperature of EuSe (T/sub N/ = 4.6K) at 24 GHz exhibits a broad maximum at ~12°K. Additional results at 9.05, 18.26, and 35.25 GHz were obtained. At 35.25 GHz, no linewidth peak is observed while at 9.05 GHz the peak is strongest and occurs at ~T/sub N/. The behavior is qualitatively interpreted following Tomita and Kawasaki. Measured linewidths versus temperature and proportional to the product of the lifetime and the density of fluctuations. Increasing the field (frequency) at a fixed temperature decreases the fluctuation density and decreases the linewidth. In large fields, the linewidth dependence on the critical divergence in fluctuation lifetimes is completely obscured, but at low fields, dominates the observed temperature dependence. The maximum linewidth with increasing T at T > T/sub N/ occurs when the increasing density of fluctuations compensates the decreasing lifetime. At 9.05 GHz, the excess linewidth due to fluctuations can be described by $\Delta H\text{-}\Delta H(T=\alpha)\sim(T\text{-}T/\text{sub N/})/\text{sup delta/}$ with delta = -1.33 and does not agree with the value delta congruent to $-^2/_3$ predicted by Tomita and Kawasaki. (auth)

3518 Crystal-field and magnetic moment direction in rare earth—silicon intermetallic compounds RSi of CrB type (R = Tb, Dy, Ho, Er, Tm). Nguyen, V.N.; Rossat-Mignod, J.; Tcheou, F. (CEN, Grenoble, France). *Solid State Commun.*; **17**: No. 2, 101-105(15 Jul 1975).

Using crystal-field calculation within a point charge model, the rare-earth magnetic moment direction is interpreted in the equiatomic rare earth-silicon compounds of CrB type. It is shown that the 2nd order crystal-field parameter V_2^2 is predominant and implies the magnetic moment to the perpendicular to the two-fold quantization axis, i.e. b-axis. The calculated magnetic moment direction is in good agreement with neutron diffraction results. (auth)

3519 (UCRL—76924) **5d band effects in Cs, Xe, and I.** Grover, R.; Mc Mahan, A.K.; Ross, M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Jun 1975. 4p. (CONF-750960—1). Dep. NTIS $4.00.

From International conference on electronic properties of solids under high pressure; Heverle, Belgium (1 Sep 1975).

Properties of shock compressed iodine at high pressure are compared with those of Cs and Xe treated similarly. At high compressions these elements have a common characteristic in the rapidly lowering 5d band. In cesium this results in the well known first order phase transition at 42 kbar. In xenon the lowering 5d band has been shown to lead to severe softening of the shock Hugoniot. Any manifestation of the 5d band in these experiments must occur via thermal effects. Thermal effects are known to play a dramatic role in the shock compression of xenon. Xenon is normally an insulator with a filled 5p band. As with iodine, the 5d band is too high up to play any role at low temperatures except under the most extreme compressions. Shock compression experiments, however, can achieve temperatures in excess of 1 eV. Under these conditions a significant number of 5p electrons can be excited into the 5d band. Their effect is further greatly enhanced by the fact that 5p-5d gap is rapidly decreasing with compression. The net effect is to dramatically soften the Hugoniot in the vicinity of 20-22 cc/mole. It is this effect which may be partially, or perhaps totally, responsible for the softening in the iodine Hugoniot near 14 cc/mole. (JRD)

3520 Low-temperature thermal and mechanical properties of polystyrene and polyethylene foams. Foley, R.J. (Univ. of California, Livermore); Jelinek, F.J. pp 439-442 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

An experimental study was conducted to determine the thermal contraction and thermal conductivity of polystyrene-beaded foams of densities 0.05 and 0.1 g/cm³ and open-cell polyethylene foam of density 0.22 g/cm³. Values are given in the range from 4 to 300°K. Compressive and tensile strength properties were evaluated for the polystyrene foams at 300, 77, and 20°K. Thermal contraction behavior of the polystyrene foam materials appears to be nearly independent of density. However, thermal conductivity of the material was affected by density changes when evacuated to 1.3×10^{-4} Pa to reduce the effect of gas conduction. The compressive and tensile strengths also appear to be affected by density. Thermal contraction and conductivity results indicate the anisotropic effects in the contraction behavior of the polyethylene material. (auth)

3521 Pressure dependence of the rare earth Knight shift in the singlet ground state systems PrP and TmP. Weaver, H.T.; Schirber, J.E. (Sandia Labs., Albuquerque, NM). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 49-50(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The pressure of dependence of the Knight shift (K) for ^{141}Pr in PrP and ^{169}Tm in TmP at 4°K was found to be d ln K/dP = 0.83 percent and 0.48 percent kbar, respectively. Both compounds are paramagnetic but exhibit a temperature independent (Van Vleck) susceptibility near T = 0 due to the crystal field induced-singlet electronic ground state. The rare earth Knight shift provides a direct measurement of the susceptibility (X/sub vy/), from which the crystal field splitting (Δ) may be determined, i.e., X/sub vv/ α Δ^{-1}. Thus, the result of d ln K/dP > 0 is in qualitative disagreement with the usually successful effective point charge model. Such a model implies that Δ varies as some inverse power of the lattice constant and, consequently, that the pressure derivative (d ln K/dP) is a negative. Anomalous conduction electron-nuclear coupling effects were checked for by measuring the pressure dependence of the ^{31}P Knight shift in PrP. However, the observed d ln K/dP (1.6 percent kbar) excludes this possibility and probably results from the same susceptibility change that is responsible for the rare earth resonance behavior. (auth)

3522 Direct observation of the spin-reorientation transition at Yb sites in $YbFeO_3$. Davidson, G.R. (Argonne National Lab., IL); Dunlap, B.D.; Eibschutz, M.; van Uitert, L.G. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 63-64(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

A direct observation is reported of a 90° reorientation of Yb spins in $YbFeO_3$ by Moessbauer spectroscopy of single crystals. The spectra are consistent with a continuous rotation of the Yb spins in the region 6.6°K less than or equal to T less than or equal to 7.8°K with second-order phase transitions at the end points. Results agree with qualitative predictions by Horner and Varma and by Yamaguchi, but the quantitative predictions of Yamaguchi are found not to apply to $YbFeO_3$. (auth)

3523 Spin waves in an amorphous metallic ferromagnet. Axe, J.D. (Brookhaven National Lab., Upton, NY); Passell, L.; Tsuei, C.C. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 119-120(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Low-angle inelastic neutron scattering experiments were carried out on the amorphous ferromagnet $Fe_{75}P_{15}C_{10}$, with a Curie temperature T/sub c/ = 597°K. At reduced temperatures, t = T/T/sub c/, between 0.5 and 0.83, well-defined spin waves were observed with propagation vectors /q/ = 2π/lambda < 0.18 A^{-1} with a ferromagnetic dispersion relation $\hbar\omega = D(T)q^2 + E(T)q^4$. Inability to close the scattering triangle rather than intrinsic broadening prevents extension of the measurements to even shorter wavelengths. At room temperature D = 149.5(+-3)meV-A^2 and E = 680(+-200) meV-A^4. (auth)

3524 Application of the narrow band model for disordered ferromagnetic alloys to the solid solutions Fe/sub 1-x/Co/sub x/S_2 and Ni/sub 1-x/Co/sub x/S_2. Abito, G.F. (Ames Lab., IA); Schweitzer, J.W. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 345-346(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The narrow band model of Hubbard, generalized for random disordered alloys, is used to discuss the ferromagnetism in the pyrite solid solutions Fe/sub 1-x/Co/sub x/S_2 and Ni/sub 1-x/Co/sub x/S_2. This discussion is made within the coherent potential approximation for treating disorder. (auth)

3525 Magnetic ordering in several Fe-chain silicate compounds. Borg, R.J. (Univ. of California, Livermore); Szofran, F.R.;

Burmester, W.L.; Sellmyer, D.J. *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 365-366(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

Magnetic ordering in selected Fe-chain silicate compounds was studied with Moessbauer, high-field magnetization, and susceptibility measurements. The compounds have the monoclinic crystal structure and the general formula (Na,Ca)/sub 2-3/(Fe^{+2},Fe^{+3}, Mg, Al)$_9$$Si_8$B—22(OH,F) .;The stacking sequence of the Fe atoms forms a one dimensional chain along the [001] axis. The appearance of magnetic hyperfine splitting was used to determine magnetic ordering temperatures which range from 6.2 to 26.0°K. In one of the compounds, the Fe^{+3} spins was shown to be canted at 29° from [001] and the susceptibility has shown the ordering to be antiferromagnetic. Magnetization evidence for high field spin transitions to the paramagnetic state has been obtained. Evidence for the presence of ferromagnetic and antiferromagnetic interactions is discussed. (auth)

3526 Effect of ionized centers on the electron drift velocity in CdTe. Canali, C. (Univ., Modena, Italy); Nava, F.; Ottaviani, G.; Zanio, K. *Phys. Status Solidi (a);* **28**: No. 2, 581-590(16 Apr 1975).

The electron drift velocity was studied with the time-of-flight technique as a function of electric field (2 to 50 kV/cm) and temperature (80 to 300°K) in high resistivity compensated CdTe containing from 1 to 100 ppM of indium. In the lightly doped material, electron drift velocity is limited by the Coulombic scattering due to ionized centers and agrees with the theoretical predictions. In the more heavily doped material, electron transport is limited by trapping and detrapping effects by a level at 0.048 eV and is strongly dependent upon the electric field. At low electric fields (E less than or equal to 6 kV/cm), the data are interpreted by a lowering of the Coulomb potential barrier around the trapping centers (Poole--Frenkel effect). At higher fields (E greater than or equal to 12 kV/cm) and lower temperatures (T less than or equal to 110°K), the reduced mobility varies as exp (1/E). This is interpreted as reemission from traps due to tunneling. These scattering and trapping effects are likely to be important even at high electric fields where th Gunn effect occurs in low resistivity material. The threshold field increases and the maximum drift velocity decreases with increasing concentrations of scattering and trapping centers. (auth)

3527 Electron charge densities in PbSe and PbTe. Schlueter, M.; Martinez, G.; Cohen, M.L. (Univ. of California, Berkeley). *Phys. Rev. Lett.;* **11**: No. 10, 3808-3813(15 May 1975).

Electronic charge densities for PbSe and PbTe are derived from recent pseudopotential-band-structure calculations and results are displayed as contour plots for individual bands and for the total valence charge. Fractional amounts of charge inside touching spheres around each atom are calculated for different l values by an angular momentum projection method. Rough estimates of the charge transfers in PbSe and PbTe are made. The charge densities for the states forming the gap at the point L of the Brillouin zone are presented and related to pressure and temperature coefficients of the fundamental gap. (auth)

3528 Fourth-order elastic constants and the temperature dependence of second-order elastic constants in cubic materials. Garber, J.A.; Granato, A.V. (Univ. of Illinois, Urbana). *Phys. Rev. Lett.;* **11**: No. 10, 3998-4007(15 May 1975).

A theory analyzing the temperature dependence of second-order elastic constants on the basis of a quasiharmonic-anisotropic-continuum model is applied to LiBr, KCl, RbF, β-brass, Cu, Ag, and Au. The number of fourth-order elastic constants is reduced from 11 to 2 by assuming that nearest-neighbor (nn) and next-nearest-neighbor (nnn) central-force interactions predominate in fourth order. The fourth-order elastic constants found from the experimental results show that nn interactions are dominant for the NaCl structure and that nnn interactions are dominant for the CsCl structure, as would be expected for a potential containing a term describing a rapidly varying central-core repulsion. Using recent measurements for Cu in the low-temperature T^4 regime where the anisotropic-continuum theory should be exact, a potential is derived which is in close agreement with one used extensively in point-defect calculations. (6 tables) (auth)

3529 Forced gauge invariance of the spin hamiltonian for homonuclear diatomic centers. Lagendijk, A.; Schoemaker, D. (Argonne National Lab., IL). *Phys. Rev. Lett.;* **11**: No. 10, 4030-4032(15 May 1975).

It is shown that the condition of gauge invariance for the g values of the V/sub k/ center can be used to find the s mixing in the unpaired-hole orbital. Using experimental hyperfine-structure data, the internuclear distances of the various V/sub k/ centers in alkali halides are calculated. (auth)

3530 Neutron-scattering study of the one-dimensional conductor $K_2Pt(CN)_4Br_{0.3}.3.2D_2O$ (KCP). Lynn, J.W. (Brookhaven National Lab., Upton, NY); Iizumi, M.; Shirane, G.; Werner, S.A.; Saillant, R.B. *Phys. Rev., B;* **12**: No. 4, 1154-1166(15 Aug 1975).

The triple-axis neutron technique has been used to make a detailed temperature-dependent study of the scattering associated with the 2 k/sub f/ instability discovered by Comes et al. and subsequently studied by Renker et al. in the one-dimensional (1-D) conductor $K_2Pt(CN)_4Br_{0.3}.3.2D_2O$(KCP). At low temperatures, they found that the elastic scattering on the planes perpendicular to the conducting c axis at Q/sub z/ = 2k/sub f/ was confined to relatively narrow peaks, and that with increasing temperature these peaks became diffuse perpendicular to vector c. It is found that the elastic scattering can be quantitatively described by assuming there are static (or quasistatic) charge-density waves (CDW) in the parallel $Pt(CN)_4$ chains, with a temperature-dependent interchain correlation length. The observed asymmetry of the scattering perpendicular to vector c is due to the variation of the structure factor of the $Pt(CN)_4$ complexes, which respond as a unit to the CDW. At elevated temperatures, the elastic scattering approaches the 1-D form expected for uncorrelated CDW's in chains of $Pt(CN)_4$. The temperature variation of the amplitude of the CDW in each chain is obtained from the data, and is found to decrease slowly with increasing temperature above 80°K. The width of the scattering along the chain direction remains very narrow at all temperatures, and for T less than or approximately equal to 160°K a lower limit to the intrachain correlationlength of 300 A has been set. The inelastic scattering in the vicinity of the 2k/sub f/ instability extends to lower energies than previously observed and in fact appears to fall to E approximately equal to 0 for all temperatures in the range 80 to 300°K. These results are interpreted to indicate that at room temperature the CDW distortion has already manifested itself in the lattice, and that the development of interchain correlations at low temperatures is not directly related to a Peierls-type transition. (auth)

3531 Compressibility of selenium glass to 5 GPa. Singh, A.K.; Kennedy, G.C. (Univ. of California, Los Angeles). *J. Appl. Phys.;* **46**: No. 9, 3861-3865(Sep 1975).

The compressibility of selenium glass has been measured to 5.0 GPa by a piston-cyliner apparatus. The discontinuity in the pressure derivative of the compressibility reported by Bridgman is not observed is this study; the compression behavior is found to be normal up to 5.0 GPa. The variation of the bulk modulus B(p) can be described by the relation $B(p) = B_o + B_o'p + (1/2)B_o''p^2 + (1/6)B_o'''b'3$ with B_o =8.73 plus or minus 0.4 GPa, B_o' =4.15 plus or minus 0.7 $(GPa)^{-1}$, and B_o''' = 0.219 plus or minus 0.2 $(GPa)^{-2}$. (auth)

3532 Spectral acceptance for second-harmonic generation in CD*A. Taylor, D.J. (Los Alamos Scientific Lab., NM). *J. Appl. Phys.;* **46**: No. 9, 3988-3991(Sep 1975).

The efficiency of second-harmonic generation (SHG) in a crystal is reduced if the laser spectral width Δ lambda/sub F/ is too large. The measurement is presented of the spectral acceptance width $\Delta\lambda$/sub A/ in cesium dideuterium arsenate (CD*A) at the fundamental wavelength of 1.06 μm using a narrow-band tunable Nd:glass laser, with the result $L\Delta\lambda$/sub A/ = 2.25 cm nm, where L is the crystal length. The theory presented here of SHG with a broad-band fundamental shows that SHG efficiency declines as $\Delta\lambda$/sub A//$\Delta\lambda$/sub F/ when $\Delta\lambda$/sub F/ is increased beyond $\Delta\lambda$/sub A/. Achievement of 90 percent of the narrow-band SHG efficiency requires that a Q-switched Nd:glass laser be spectrally narrowed to 1.5 nm for a 1.5-cm CD*A crystal. (auth)

CORROSION, EROSION, AND DEGRADATION

3533 (SAND—75-0538) **Thermal acceleration of ozone interaction with graphite and other organocarbons.** Hof, G.J.; Sharp, D.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 15p. Dep. NTIS $4.50.

Reactions of ozone with graphite and selected hydrocarbons at elevated temperatures were investigated. An energy activation curve for graphite was generated and the activation energy for graphite at the temperature range of 30 to 180°C was determined to be 16.8 kcal/mole. Mildly activated flux from a hybrid microcircuit soldering operation, not completely removable by solvents, and preventing reliable thermocompression bonding, may be completely removed in 5 minutes by corona discharge generated ozone in oxygen when reaction is promoted at 150°C. (auth)

RADIATION EFFECTS

3534 (SLL—73-0287) **Summary of preliminary studies on the effects of ^{60}Co gamma-ray irradiation of fiber optic materials.** Mattern, P.L. (Sandia Labs., Livermore, Calif. (USA)). Oct 1973. Contract AT(29-1)-789. 64p. Dep. NTIS $5.00.

Absorption induced by irradiation was measured from 185 to 1500 nm, using a computer-controlled Cary 17I spectrophotometer. Results indicate that most conventional fiber core glasses develop significant absorption bands in the near uv, visible, and near infrared regions at low doses (less than 10^4 rad). In polystyrene, the radiation-induced absorption losses are less severe. Two types of high purity synthetic fused silica were affected least of all by irradiation. In these vitreous silicas the only significant absorption bands observed were in the ultraviolet. (21 figures) (auth)

3535 (UCRL-Trans—10947) **Delay in boiling of liquid sheet glass with electron irradiation.** Dudek, H.J. Translated from *Naturwissenschaften;* **57**: No. 9, 450(Sep 1970). 5p. Dep. NTIS $4.50.

When a well-collimated electron beam of 100 keV hits the surface of material, either formation of holes (eruption) or melting occurs. In sheet glass, holes can be drilled with this method, but if the glass moves during irradiation, the material boils and forms glass foam. Various transition states between hole formation and boiling can be obtained by varying pulse frequency, impulse duration, beam diameter, and speed of glass motion. (DLC)

3536 **Luminescence in solid krypton.** Reynolds, C.L. Jr.; Couchman, P.R. (Univ. of Virginia, Charlottesville). *Phys. Rev. Lett.;* **11**: No. 10, 4061-4062(15 May 1975).

Measurements by Lewis and Teegarden of the x-ray-induced luminescence of solid Kr were reanalyzed on the basis of simple rate theory. For irradiation times greater than 20 s, agreement between theory and experiment is excellent. (auth)

3537 **Temperature dependence of Frenkel-pair production from F-aggregate center destruction.** Sonder, E. (Oak Ridge National Lab., TN). *Phys. Rev., B;* **12**: No. 4, 1516-1521(15 Aug 1975).

Measurements of the radiation destruction of F-aggregate centers between 70 and 250°K have yielded values for the primary-Frenkel-pair production efficiencies in NaCl, RbCl, KBr, and KI as a function of temperature. The so far unexplained increase in production efficiency with temperature originally demonstrated for KCl has also been observed in these materials, and has been found to be only a slight function of the species of cation, but a strong function of anion species making up the alkali halides. The apparent agreement between the activation energy obtained for KBr in these measurements and pulsed radiolysis measurements is discussed, and a problem concerning previously proposed explanations is indicated. In addition, the very strong temperature dependence previously observed in KI and attributed to the disappearance of luminescence has been observed and correlated with the thermal quenching of the 3.31-eV component of the fundamental luminescence. (auth)

CHEMISTRY

ANALYTICAL AND SEPARATIONS CHEMISTRY

CHEMICAL PROCEDURES

3538 (LA—6039) **Accurate determination of impurity concentrations in plutonium metals by statistical evaluation of analytical data.** Martell, C.J.; Tietjen, G.L.; Horita, M.M. (Los Alamos Scientific Lab., N.Mex. (USA)). Jul 1975. Contract W-7405-ENG-36. 48p. Dep. NTIS $4.00.

Analytical data from a plutonium-metal exchange program conducted by six ERDA laboratories are statistically evaluated. The objective is an accurate determination of five metal impurities (aluminum, chromium, iron, nickel, silicon) in each of three plutonium metals by using data from four analytical methods. The statistical evaluation yields the weighted mean and its standard deviation for each method, plutonium metal, and impurity, using a procedure that minimizes the effect of outliers by assigning zero weights to the most extreme values and variable weights to the remaining data. Where possible, weighted means from the various analytical methods are pooled. (auth)

3539 (MHSMP—75-5K) **Determination of inorganic chlorides in TATB.** Kohn, E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). Dec 1974. 10p. Dep. NTIS $4.50.

1,3,5-triamino trinitrobenzene (TATB) prepared by the action of ammonia on 1,3,5-trichloro trinitrobenzene (TCTNB) contains a significant amount of inorganic chlorides, particularly ammonium chloride, which are not satisfactorily determined by washing procedures. A method is described herein, which consists of dissolving TATB in concentrated sulfuric acid, purging and collecting the liberated hydrogen chloride in dilute base, and analyzing potentiometrically for chloride ion with an ion-selective electrode. To ascertain that organic chlorides present in the TATB do not interfere by also producing hydrogen chloride, organic impurities normally found in TATB were subjected to the same experimental conditions and were found not to yield hydrogen chloride. A number of TATB samples were analyzed by the technique described and it was found that the chlorine content of these samples was largely of the inorganic type. Because of uncertainties in the presently available method for total chlorides, it was not possible to ascertain the relative proportions of organic and inorganic chlorides in the samples examined. (auth)

3540 (MHSMP—75-24F) **Determination of total nitration of TATB. Period covered: April—June 1975.** MacDougall, C.S. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 7p. Dep. NTIS $4.50.

A titrimetric determination of organic nitro was adapted to the analysis of total nitration of TATB (1,3,5-triamino-2,4,6-trinitrobenzene). The procedure involves a quantitative reduction of the nitro groups to amines using excess Cr^{+2} is then titrated with Fe^{+3} using phenosapharanine as an indicator. The method requires a 5 mg sample of TATB, and the reaction takes place in an acetic acid--water medium. One reaction begins as a solid--liquid 2-phase system, but as the TATB is reduced, the reaction products dissolve in the titration medium. The relative standard deviation of this method is plus or minus 6.5 percent for measuring approximately 2.5 mg amounts of nitro. Approximately 3 samples can be analyzed in duplicate in an 8 hour day. The other method involves a prior dissolution of the TATB in HCl--acetic acid. An aliquot of the TATB is then titrated with the Cr^{+2}. This titration, however, gives drastically low results. (auth)

3541 (MHSMP—75-24N) **Compositional analysis of viton used in explosives. Period covered: April—June 1975.** MacDougall, C.S. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 3p. Dep. NTIS $4.50.

A specific ion electrode method was used to determine fluorine in Viton, a polymer containing F, C, and H. Carbon and hydrogen were determined by a combustion--gas chromatographic method. Approximately 3 complete assays, in duplicate, could be performed in an 8 hour day. The methods are sensitive to 200 μg fluorine and less than 0.1 μg hydrogen and carbon. Analysis of a standard Viton sample previously analyzed for fluorine showed recovery of fluorine to be 99.9 plus or minus 0.1 percent. Carbon is 100 percent recovered. Recovery of hydrogen is approximately 100 percent. Total component analysis gave 99.5 to 100.5 percent or nearly complete closure of analysis. (auth)

3542 (MHSMP—75-24P) **Liquid chromatographic determination of nitrocellulose and CEF in PBX 9404. Period covered: April—June 1975.** MacDougall, C.S.; McGaugh, G.E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 8p. Dep. NTIS $4.50.

A high speed liquid chromatographic method for determination of nitrocellulose (NC) and tris (β-chloroethyl) phosphate (CEF) in PBX 9404, a plastic-bonded explosive was developed. A 1 g sample of explosive is extracted with 10 ml tetrahydrofuran (THF) for 1 hour after which the mixture is centrifuged. A 40 μl aliquot of the supernatant is then injected into a liquid chromatographic system using a 5 m Corasil II column and a THF carrier at ~ 0.6 ml/min flow rate. The separated NC and CEF components are measured with a differential uv-detector and RI detector, respectively. The amounts of NC and CEF are then calculated from measured peak heights. Analyses of standards show recovery of NC to be 99.2 +- 0.7 percent, while CEF is 97.3 +- 0.9 percent recovered. Approximately six samples in duplicate can be analyzed in an 8-hour day. (auth)

3543 (MHSMP—75-36B) **Detailed examination of aging processes of PBX 9404. Period covered, April—June 1975.** MacDougall, C.S.; Remling, D.K.; Kuepper, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 24p. Dep. NTIS $4.50.

For Lawrence Livermore Lab., CA.

Progress in studies on PBX 9404, a plastic-bonded chemical explosive, and its binder is reported. An understanding of degradation processes is critical to predicting weapons' shelf lives. Samples were chosen from archival supplies, as well as from actual units. Methods for analysis of the main component, HMX (cyclotetramethylenetetranitramine), as well as the binder materials, nitrocellulose, tris (β-chloroethyl) phosphate, and diphenylamine, are reported. The extent of nitration of diphenylamine in samples of various ages is of particular interest, and was studied by liquid chromatography. Nitrogen was determined in nitrocellulose by a spectrophotometric method. (JGB)

3544 (MHSMP—75-245) **Polargraphic analysis of HMX in LX-09. Period covered: April—June 1975.** Faubion, B.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 6p. Dep. NTIS $4.50.

A method for the analysis of HMX in LX-09 using differential pulsed polarography has been investigated. The polarograms were obtained on solutions of HMX in 20 percent Acetone/80 percent 0.05 M sodium sulfite-sodium borate buffer and in 20 percent DMSO/80 percent 0.05 M sodium sulfite-sodium borate buffer. In the first solvent system the HMX is reduced at the dropping mercury electrode at a potential of -0.825 V versus the saturated calomel electrode (SCE) and in the second solvent system at -0.745 V versus SCE. In both systems the peak heights are linear with respect to concentration over the range 0 to 100 ppm. (auth)

3545 (ORNL-TM—4777, pp 60-104) **Advanced analytical techniques.** Jul 1975.

In Experimental Engineering Section semiannual progress report.

Evaluation of the high-resolution body fluid analyzers (UV-Analyzers) at other laboratories was concluded in June 1974, and ownership of the prototype systems and related equipment was transferred to the users as of July 1, 1974. The cerate oxidimetric detector was applied to carbohydrate analysis, and several neutral carbohydrates were separated and identified in serum and plant glycoproteins. Additional uv-absorbing body fluids constituents were identified, bringing the total number to 135. One newly identified compound, 4-hydroxy-3-methylthioacetanilide, is a metabolite of acetaminophen which may have important physiological and toxicological implications. The excretion rates of this compound and other metabolites of acetaminophen were determined for two subjects. The second prototype of a system to process 16 whole-blood samples (per rotor) into plasma and cell fractions has been evaluated, and a third prototype has been designed. An instrument that combines the techniques of electrophoresis and liquid chromatography in a single system has been designed and evaluated, and feasibility studies have been conducted. In addition, a centrifugal chromatograph has been designed and a prototype fabricated. Results from the preliminary evaluation of this prototype are encouraging. (auth)

3546 (UCRL-Trans—10937) **Preparation of neutral lipophilic ligands for membrane electrodes with selectivity for alkaline-earth ions.** Ammann, D.; Pretsch, E.; Simon, W. Translated from *Helv. Chim. Acta;* **56**: No. 5, 1780-1787(1973). 17p. Dep. NTIS $4.50.

The preparation of a series of non-cyclic, electrically neutral ligands, able to selectively complex alkaline earth metal cations, is described. Some of the compounds show high Ca^{2+} selectivity in membrane electrodes. (auth)

3547 (UCRL-Trans—10936) **Model calculation of the emf and ion selectivity of electrochemical cells containing membrane electrodes.** Wuhrmann, H.R.; Morf, W.E.; Simon, W. Translated from *Helv. Chim. Acta;* **56**: No. 3, 1011-1028(1973). 30p. Dep. NTIS $5.00.

Based on a set of clearly specified assumptions, a universal integral equation is derived which describes the steady-state EMF of an electrochemical cell containing any type of ion-selective membrane electrode. The various modes of delineating that phenomenon ion-selectivity by an explicit function are shown. For all types of analytically important ion-sensitive electrodes, the selectivity between monovalent cations and anions, respectively, can be neatly and comprehensively rationalized. These theoretically derivable expressions are compiled. (auth)

RADIOMETRIC AND RADIOCHEMICAL PROCEDURES

3548 (UCRL—52000-75-8, pp 17-18) **National security.** Aug 1975.

In Lawrence Livermore Laboratory energy and technology review.

An x-ray-fluorescence analysis system is being developed for determining uranium and plutonium concentrations in the solution obtained when the fuel rods from light-water power reactors are dissolved in nitric acid. These concentrations are needed to inventory the uranium and plutonium handled in fuel reprocessing plants. This technique should make it possible to analyze dissolver solution with speed and a 0.5 percent accuracy. (auth)

3549 (UCRL-Trans—10732) **Determination of neptunium in the presence of plutonium and uranium by x-ray spectrometry.** Ertel, D.; Wettstein, W. Translated from *Z. Anal. Chem.;* **266**: No. 1, 29-30(1973). 6p. Dep. NTIS $4.00.

Methods are discussed for overcoming difficulties caused by overlapping of peaks in the x-ray fluorescence analysis of neptunium in the presence of plutonium and uranium. Apart from chemical separations, there are two possibilities of attenuating or eliminating interference due to peak overlap, namely the use of analyzer crystals with larger dispersion or measurement of lines of a higher order. (LK)

3550 (RFP-Trans—167) **Recent developments in plutonium analysis.** 1974. Translation of CEA-CONF—2692. 16p. Dep. NTIS $4.00.

The development of the analytical chemistry of plutonium has been pursued in three directions in recent years: high-precision analysis, atomic absorption analysis and x-ray fluorescence analysis. The methods of titration by oxydoreduction permit precision between 0.05 and 0.1 percent in determining plutonium in metal and mixed oxides from the core [literally drawplate, screw plate] of fast neutron reactors. Atomic absorption permits determination of 10^{-6} to 10^{-7} g of plutonium. An x-ray fluorescence installation is used for determination of plutonium and uranium in reprocessing solutions. (auth)

SPECTRAL PROCEDURES

3551 (ARH-CD—474) **Isotopic analysis of plutonium by computer controlled mass spectrometry.** (Atlantic Richfield Hanford Co., Richland, Wash. (USA)). 10 Apr 1974. Contract E(45-1)-2130. 42p. Dep. NTIS $5.00.

Isotopic analysis of plutonium chemically purified by ion exchange is achieved using a thermal ionization mass spectrometer. Data acquisition from and control of the instrument is done automatically with a dedicated system computer in real time with subsequent automatic data reduction and reporting. Separation of isotopes is achieved by varying the ion accelerating high voltage with accurate computer control. (auth)

3552 (JUL—1210) **Influence of additives and homogeneous magnetic fields on the electric arc applied as source for spectrochemical excitation.** Schaeps, R. (Kernforschungsanlage Juelich G.m.b.H. (F.R. Germany). Inst. fuer Reaktorwerkstoffe und Heisse Zellen). Jun 1975. 112p. (In German). Dep. NTIS (US Sales Only) $6.50.

Thesis. Submitted to Technische Hochschule, Aachen.

A report is given on some basic investigations concerning the influence of additives and of a homogeneous magnetic field on the spectroscopic analysis of graphite and of titania mixtures in a 10 A arc. The influence of a homogeneous magnetic field on the integral line intensity of different trace elements (Hg, Zn, Ga, Tl) in graphite and on their axial and radial distribution in an arc plasma is described in detail. Parameters were the strength of the magnetic field (0, 100, 200, 400 G) and the physical properties of the trace elements, e.g. their mass and ionization potential. By nondestructive and continuous x-ray absorption measurements, the evaporation of some metal oxides from graphite anodes was determined and plotted against the strength of the magnetic field. As a particular result the influence of the added Ga_2O_3 on the line intensity of trace elements in a graphite matrix was found to depend on the concentration of Ga_2O_3 and the ionization potential of the elements investigated. In analysis of the titania--graphite mixtures it could be demonstrated that, contrary to PTFE as an additive, Ga_2O_3 has an arc stabilizing effect. (auth)

3553 (LA—6042-PR) **Development of sampling and analytical methods for carcinogens. Progress report, July 1—December 31, 1974.** Weeks, R.W. Jr.; Morales, R.; Rappaport, S.M.; Ettinger, H.J.; Campbell, E.E. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 21p. Dep. NTIS $4.00.

The facilities, aerosol/vapor generation and sampling systems, chemical spot tests, and analytical instrumentation for developing sampling and analytical procedures for the 14 "OSHA (Occupational Safety and Health Administration) Carcinogens" are discussed. (auth)

3554 (MHSMP—75-24-0) **Spectrophotometric determination of PDNPA in LX-09. Period covered, April—June 1975.** MacDougall, C.S.; Jacobs, B.J. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 9p. Dep. NTIS $4.50.

An infrared spectrophotometric method was developed for determining poly(dinitropropyl acrylate) (PDNPA) in LX-09, a plastic-bonded explosive. A sample containing about 275 mg of PDNPA is extracted with 100 ml of 1,2-dichloroethane. The mixture is agitated for 20 minutes, centrifuged, and allowed to sit undisturbed for 8 to 10 days at -5°C. The mixture is then brought to room temperature after which an aliquot of the supernatant is transferred to a 0.25 mm NaCl cell and the ir spectrum at 1752 cm^{-1} measured. The percent PDNPA is then calculated from the measured peak height. (auth)

3555 (MHSMP—75-24Q) **Spectrophotometric determination of HMX in PBX 9404. Period covered: April—June 1975.** MacDougall, C.S.; Bellamy, K.K. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 10p. Dep. NTIS $4.50.

An infrared spectrophotometric method was developed for determining HMX (cyclotetramethylenetetranitramine) in PBX 9404 (a plastic-bonded explosive). In this method a sample of explosive containing about 0.450 g HMX is dissolved in 100 ml of dimethylsulfoxide (DMSO). The mixture is then mechanically shaken for approximately 0.5 hour. An aliquot of the solution is transferred to a 0.5 mm NaCl cell and the ir spectrum at 1550 cm^{-1} measured. The percent HMX is then calculated from the measured nitro peak. Approximately four samples in triplicate can be analyzed in an 8 hour day. The method is versatile, capable of measuring quantities of HMX of 1 to 1000 mg, depending upon the size of standard which is chosen. Comparison of analyses with previous assays shows recovery to be essentially 100 percent and without bias. The relative standard deviation for measuring 450 mg of HMX is +- 0.2 percent. (auth)

SEPARATION PROCEDURES

3556 (CEA-R—4678) **High pressure liquid chromatography and its application to the separation of polynuclear aromatic hydrocarbons in atmospheric dust and burning residues.** Lopez, M.C. (CEA Centre d'Etudes Nucleaires de Grenoble, 38 (France). Service de Protection et des Etudes d'Environnement). Sep 1975. 43p. (In French). Dep. NTIS (US Sales Only) $5.25.

A description is given of a new technique of analysis, high-speed liquid chromatography, or more exactly the high performance liquid chromatography, because of the progress achieved on the new packings of the columns. The main types of chromatography, according to the phenomena involved, are described: adsorption, partition, ion-exchange and exclusion chromatography. A brief outline is given of the theory for determination of stationary and mobile phases in order to obtain the optimum conditions of separation. Some examples of possible applications are given, particularly the use of this technique for the separation of polycyclic aromatic hydrocarbons in atmospheric pollution and burning residues. (auth)

3557 (DP—1391) **SOLVEX: a computer program for simulation of solvent extraction processes.** Scotten, W.C. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Sep 1975. Contract AT(07-2)-1. 35p. Dep. NTIS $4.00.

SOLVEX is a FORTRAN IV computer program that simulates the dynamic behavior of solvent extraction processes conducted in mixer-settlers and centrifugal contactors. Two options permit terminating dynamic phases by time or by achieving steady state, and a third option permits artificial rapid close to steady state. Thus the program is well suited to multiple phases of dynamic problems and multiple input of steady state problems. Changes from the previous problem are the only inputs required for each succeeding problem. Distribution data can be supplied by two-variable third-power polynomial equations or by three-variable tables in any one of 16 different combinations involving phase concentrations or distribution coefficients (ratio of phase concentrations) or their logarithms. (auth)

3558 (ANL-Trans—1002) **Influence of the geometry properties of support materials on the efficiency of an extraction chromatography system. II. Variation of the exchange kinetics of Eu^{3+} in the HDEHP*—SiO_2—HCl system as a function of the pore size of the support materials (matrices).** Specht, S.; Nolte, R.F.; Born, H.J. Translated from *J. Chromatogr.*; **110**: 253-264(1975). 14p. Dep. NTIS $4.50.

The kinetics of europium exchange were studied as a function of the pore size of the solid support with the HDEHP-HCl partition chromatography system. Spherical silica gel particles with an average diameter of 56 μm were investigated and found to have surfaces between 1 and 195 m^2/g and the median pore diameter in the range of 117-5,500 A. The coating of the silylated support material was 10 percent by weight. The kinetics of the europium exchange were found to be a heterogenous, transport-controlled reaction in the aqueous phase. The unsteady exchange is described by Fick's second law. The transportation of the HDEHP-molecules from the interface into the aqueous phase must be considered to be the rate-determining step. Its length (= distance between the interface and the layer where the complex ion is formed) as well as the variable hindrance due to different pore size of this rate-determining step was investigated. Four pore size ranges were discussed, in each of which the transport reaction is hindered to a greater or smaller extent. Thus we could demonstrate that in the case of a pore size range with pore diameters greater than 2 μm the rate of exchange is comparable to the rate of a solvent extraction system. The variation of the rate of exchange with increasing coating of the solid support with HDEHP could be explained in the light of the above results due to the influence of the HDEHP-solubility in the aqueous phase. (auth)

INORGANIC AND PHYSICAL CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

3559 (LBL—4185) **Electron paramagnetic resonance of ions substituted in paramagnetic transition metal ion hosts.** St. John, M.R. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Nov 1975. Contract W-7405-ENG-48. 174p. Dep. NTIS $7.75.

Thesis.

Criteria for reasonably sharp spectra are presented, and the literature of observed impurity spectra in various hosts is reviewed. It is shown that unexplained line width effects can be explained in terms of host spin--lattice relaxation narrowing and spin quenching. Host spin--lattice relaxation narrowing produces sharp impurity lines when the host has a fast T_1 and the impurity has a T_1 slow enough not to broaden the lines. Mn^{2+}-substituted $(NH_4)_2Co(SO_4)_2 \cdot 6H_2O$, $K_2Ni(SO_4)_2 \cdot 6H_2O$, and $(NH_4)_2Ni(SO_4)_2 \cdot 6H_2O$ are discussed. Below 2°K, the spectra of Cu^{2+}, Co^{2+}, Mn^{2+}, and V^{2+} substituted into the partially quenched α-$NiSO_4 \cdot 6H_2O$ and $NiSeO_4 \cdot 6H_2O$ lattices were observed. For Cu^{2+}, positive shifts of 0.2 to 0.8 unit occur in the g-value when α-$NiSO_4 \cdot 6H_2O$ is compared to the isostructural $ZnSeO_4 \cdot 6H_2O$ lattice. All exchange interactions are for hydrated ions and take place through hydrogen bonds. The impurity spectra in α-$NiSO_4 \cdot 6H_2O$ and $NiSeO_4 \cdot 6H_2O$ are observed to broaden very rapidly as the temperature is raised, becoming unobservable at 4.2°K. Temperature data for Cu^{2+} substituted into α-$NiSO_4 \cdot 6H_2O$ and $NiSeO_4 \cdot 6H_2O$ are treated. (DLC)

3560 METHODS FOR MEASURING TIME SHORTENING IN NEUTRON DIFFRACTION INVESTIGATIONS WITH MONOCRYSTALS AND THEIR APPLICATION TO AMMONIUM BROMIDES. Egert, G. Tuebingen, Ger.; German, Federal Republic of (F.R. Germany); Tuebingen Univ. (1972). 70p. (In German). INIS.

Thesis.

The "monochromatic" primary beam used in neutron diffraction studies shows a relatively broad distribution of wavelengths and angles. Primary beam distributions can be generated so as to allow a measurement to be carried out with a crystal at standstill. This method is an important prerequisite to multiple detection and can be obtained using a plane mosaic monochromator in an antiparallel measuring arrangement or a curved ideal crystal monochromator. (GE)

3561 (IS-Trans—93) **Decomposition of magnesium chloride by reaction with water vapor.** da Cunha, O.G.C. Translated from *Metalurgia (Sao Paulo)*; **29**: No. 188, 425-431(1973). 19p. Dep. NTIS $4.50.

Magnesium chloride decomposition experiments conducted in accordance with the reaction $MgCl_2 + H_2O$ yields $MgO + 2HCl$ are reported. Experiments with chloride of three different granulometries were conducted by tracing the course of the reaction. Various qualitative observations were also made. (auth)

3562 Hyperfine fields and critical point exponents of some two-dimensionally layered Fe(2+) salts. Schurter, J.L. (Ames Lab., IA); Barnes, R.G.; Willett, R.D. *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 307-308(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The nuclear hyperfine properties of the two-dimensionally layered antiferromagnetic complexes, methylammonium ferrous chloride (MA_2FeCl_4) and benzylammonium ferrous chloride (BA_2FeCl_4), were studied by ^{57}Fe Moessbauer spectroscopy. Temperature dependence of the effective magnetic hyperfine fields, as well as isomer shifts and quadrupole couplings were determined by transmission experiments on powders. Saturation hyperfine fields and Neel temperatures were found to be: for MA_2FeCl_4, H(0) = 280 k0e and T/sub N/ = 95.5°K, and for BA_2FeCl_4, H(0) = 265 Oe and T/sub N/ = 75.6°K. Analysis of the hyperfine fields in terms of critical point behavior, $H(T)/H(O) = B(1 - T/T/\text{sub N}/)^{\beta}$ yields for MA_2FeCl_4, B = 1.10 and β = 0.23, and for BA_2FeCl_4 and β = 0.28. These values are compared with the predictions of the two-dimensional Ising model, B = 1.22 and β = 0.125, and with the exponents γ and γ' obtained previously from susceptibility measurements. (auth)

3563 Measurement of interchain diffusion in a quasi-one dimensional Heisenberg magnet. Richards, P.M.; Hughes, R.G. (Sandia Labs., Albuquerque, NM). *AIP (Am. Inst. Phys.) Conf. Proc.;* No. 24, 526-527(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

The characteristic time t/sub c/ for spin polarization to transfer between magnetically inequivalent chains was measured in the quasi one-dimensional salt dichlorobis (pyridine) copper (II) $[CuCl_2.2NC_5]_x$ The method utilizes the large difference in ESR linewidths between directions of applied field where the chains appear to be inequivalent and symmetry directions where they are equivalent. Data at 23 GHz are presented between 300 and 4°K and interpreted in terms of temperature variation of the interchain diffusion coefficient for T greater than or equal to 10°K and the effect of antiferromagnetic correlations at lower temperatures. The time t/sub c/ does not appear to be influenced by spin-lattice relaxation, whereas the linewidth along symmetry directions does appear to be so affected. (auth)

3564 Oscillator strengths from line absorption in a high-temperature furnace. II. The (0,0) band of the $B^2\Sigma^+ - X^2\Sigma^+$ transition in CN. Engleman, R. Jr.; Rouse, P.E. (Los Alamos Scientific Lab., NM). *J. Quant. Spectrosc. Radiat. Transfer;* 15: 831-838(1975).

Quantitative high-resolution absorption spectroscopy was applied to the (0,0) violet band of CN. The CN radical was prepared in a furnace at 1421°K containing pure cyanogen gas. Since the calculated CN concentration is dependent on the controversial CN heat of formation, only the relationship, f/sub v/ = 6.84 X 10^{-3} exp (0.354 delta), where f/sub v/ is the band oscillator strength and delta is the excess over the initially assumed $\Delta H°_{sub}$ f/(CN) = 100.8 kcal/mole, could be directly determined in this study with an estimated error in f/sub v/ of plus or minus 20 percent. For delta = 0, our f/sub v/ is a factor of 4.8 smaller than an average value of 0.033 plus or minus 0.006 derived from other measurements. If this latter value of f/sub v/ is assumed, our relationship yields $\Delta H°_{sub}$ f/(CN) = 105.3 plus or minus 1.1 kcal/mole or D_0(CN) = 7.66 plus or minus 0.05 eV. The rotational temperature and line widths for this band were also measured. (auth)

3565 Spectrum of vanadium in rare gas matrices. De Vore, T.C. (Iowa State Univ., Ames). *J. Chem. Phys.;* 62: No. 2, 520-524(15 Jan 1975).

The spectrum of V isolated in Ar and Kr matrices at 10°K has been correlated with the gas phase spectrum. The electron configuration was found to be a major factor in determining the direction and the magnitude of the matrix shift for this system. A model calculation was performed using extended Huckel theory. A plausible explanation for the origin of the matrix shifts and the altered intensity relationships observed in the matrix has been developed. (auth)

3566 Raman spectra of aluminum fluoride containing melts and the ionic equilibrium in molten cryolite type mixtures. Gilbert, B. (Univ. of Tennessee, Knoxville); Mamantov, G.; Begun, G.M. *J. Chem. Phys.;* 62: No. 3, 950-955(1 Feb 1975).

The structure of molten aluminium fluoride-alkali fluoride mixtures has been investigated by Raman spectroscopy at 700-900°C using a captive liquid windowless cell. Changes in spectra with temperature and melt composition reflect an equilibrium between the species AlF_4^- and AlF_6^{3-}. Complete spectrum of the AlF_6^{3-} was obtained confirming an octahedral coordination; the frequencies of the ν_1, ν_2, and ν_5 vibrations were found to be 555, 390, and 345 cm^{-1}, respectively. A strong cation effect on the bandwidth of the AlF_6^{3-} ν_1 band was observed when the cation is changed from Li^+ to Cs^+. This effect is believed to be due to a restriction of the rotational mobility of the anion in the presence of a smaller cation. Quantitative analysis of the intensity ratios of the AlF_4^- and AlF_6^{3-} ν_1 bands as a function of the composition of the melt permits the calculation of the stoichiometric dissociation constant K = X/sub AlF_4^-/X^2/sub F^-//X/sub AlF_6^{3-}/. An average value of 3 plus or minus 1 x 10^{-2} (concentration scale in mole fractions) was found at 780°C. The spectrum of molten cryolite was reinvestigated and found to be different from the previously published spectrum. By extrapolation of the results obtained at lower temperatures and other compositions, the AlF_6^{3-} ion in molten cryolite dissociates into AlF_4^- to the extent of approximately 25 percent at 1015°C. This degree of dissociation and the calculated ΔH of the equilibrium are in good agreement with thermodynamic and other methods of investigation. (auth)

3567 Melting parameters of methane and nitrogen from 0 to 10 kbar. Cheng, V.M. (Lafayette College, Easton, PA); Daniels, W.B.; Crawford, R.K. *Phys. Rev. Lett.;* 11: No. 10, 3972-3975(15 May 1975).

Fluid and solid molar volume and pressure-temperature melting data were obtained at pressures up to 10 kbar for nitrogen and methane. These results were combined with data from the literature to derive molar volumes of the solids at their respective triple points, and the resulting complete data sets are represented by fitted empirical equations. (auth)

3568 Magnetic ordering in terbium ethyl sulphate. Hirvonen, M.T. (Helsinki Univ. of Tech.); Katila, T.E.; Riski, K.J.; Teplov, M.A.; Malkin, B.Z.; Phillips, N.E.; Wun, M. *Phys. Rev., B;* 11: No. 11, 4652-4660(1 Jun 1975).

The magnetic properties of terbium ethyl sulphate, a singlet crystal-field ground-state system with predominantly dipolar interactions between the magnetic ions, were studied theoretically and experimentally at low temperatures. The susceptibilities parallel and perpendicular to the hexagonal c axis were measured in the temperature range 0.03-4°K by a superconducting-quantum-interference-device magnetometer in connection with a dilution refrigerator. In addition, the heat capacity of a powdered sample was measured. Results indicate a cooperative transition at 0.24°K. Data give indirect information on the value of the crystal-field splitting. The behavior of the longitudinal susceptibility is consistent with a picture of a ferromagnetic transition into long and thin domains along the c axis. The much smaller transverse susceptibility shows an unexpected abrupt change at 0.24°K. Theoretical calculations on the magnetic properties are presented. The molecular-field approximation, two- and three-particle "cluster" models and high-temperature expansion are considered in turn. The predictions of the three-particle cluster model are closest to the experimental data. (auth)

3569 Vaporization reactions in the ytterbium-fluorine system. Biefeld, R.M.; Eick, H.A. (Michigan State Univ., East Lansing). *J. Chem. Phys.;* 63: No. 3, 1190-1197(1 Aug 1975).

The vaporization and sublimation reactions for the ytterbium fluoride system have been investigated by mass loss, x-ray powder diffraction, elemental analysis, and mass spectrometry. When YbF/sub 2.00/ is heated in vacuum, it decomposes to give a metal rich vapor and a metal deficient residue until the composition YbF/sub 2.40(4)/ is reached. The following equilibrium reactions were established: YbF/sub 2.40/(s,l)/ = (0.60)YbF_2(g) + (0.40)YbF_3(g). Reaction (a); and YbF/sub 3.00/(s,l) = (0.05)YbF/sub 2.04/(s,l) + (0.95)YbF_3(g) + (0.03)F(g). Reaction (b). A target collection Knudsen effusion method was used to determine vapor pressures for the above reactions. From the slope-intercept data the following enthalpy and entropy changes with associated standard deviations were derived at the median temperatures: For Reaction (a), $\Delta H°_{1569}$ = ($94._8$ +- $1._1$) kcal mol^{-1} and $\Delta S°_{1567}$ = (36.8_3 +- 0.6_7 cal $mol^{-1}.K^{-1}$. For Reaction (b), $\Delta H°_{1569}$ = (91.1_9 +- 0.4_1) kcal mol^{-1} and $\Delta S°_{1569}$ = (58.2_8 plus or minus 0.2_6) cal $mole^{-1}.K^{-1}$. Estimated and reported thermodynamic functions were employed to reduce the thermodynamic values to 298 K. The reduced values are as follows: For reaction (a), $\Delta H°_{298}$ = ($110._7$ plus or minus $2._3$) kcal mol^{-1} and $\Delta S°_{298}$ = ($50._8$ plus or minus $2._3$) cal $mol^{-1}.K^{-1}$; for Reaction (b), $\Delta H°_{298}$ = ($111._1$ plus or minus $1._3$) kcal mol^{-1} and $\Delta S°_{298}$ = ($56._2$ plus or minus $1._3$) cal $mol^{-1}.K^{-1}$. By use of the third-law prodecure, the following $\Delta H°_{298}$ values were derived: for (a), ($109._8$ plus or minus $2._4$) kcal mol^{-1}; for (b), ($107._6$ plus or minus $3._0$) kcal mol^{-1}. The enthalpies and entropies for the hypothetical congruent sublimation reactions of YbF_2(s) and YbF_3(s) are derived and compared with those of the alkaline earth difluorides and other selected lanthanide fluoride systems. (auth)

3570 Sound velocity and the equation of state of N_2 to 22 KBAR. Mills, R.L.; Liebenberg, D.H.; Bronson, J.C. (Los alamos Scientific Lab., NM). *J. Chem. Phys.;* 63: No. 3, 1198-1204(1 Aug 1975).

The velocity of sound and the relative volume of N_2 were measured simultaneously in a piston-cylinder apparatus along five isotherms from 247 to 321 K at pressure up to 22 kbar. The data were combined to yield a consistent equation of state from which accurate thermodynamic variables can be derived. (auth)

3571 Vaporization, thermodynamics, and dissociation energy of yttrium monosulfide. Steiger, R.A.; Cater, E.D. (Ames Lab., IA). *High Temp. Sci.;* 7: No. 3, 204-214(Sep 1975).

The congruent vaporization of solid yttrium monosulfide to molecules YS and atoms Y + S from tungsten Knudsen cells was studied mass spectrometrically and with a vacuum balance in the temperature range 2050 to 2352°K. Second- and third-law thermodynamic treatments yielded good agreement. The dissociation energy of YS(g) is $D_0°$ = 125.4 +- 2.5 kcal/mol or 5.44 +- 0.11 eV. Other second-law results with standard deviations are YS(s) = YS(g), $\Delta H°_{2250}$ = 142.9 +- 0.8 kcal/mole, $\Delta S°_{2250}$ = 36.5 +- 0.4 cal/mole-deg; YS(s) = Y(g) + S(g), $\Delta H°_{2250}$ = 273.7 +- 2.5 kcal/mole; Y(s) + S(rh) = YS(s), $\Delta H°$/sub f,298.15/(YS,s) = -110

+- 3 kcal/mole. The lattice parameter of YS(s) at room temperature is a_o = 5.4873 +- 0.0004 A. The magnetic susceptibility at room temperature is 85 X 10^{-6} cgs units. (auth)

3572 First period transition metal sulfide gaseous molecules: matrix spectra, oxide—sulfide correlation, and trends. DeVore, T.C.; Franzen, H.F. (Ames Lab., IA). Contract W-7405-eng-82. *High Temp. Sci.*; 7: No. 3, 220-235(Sep 1975).

Infrared spectra for the gaseous monosulfides of Ti, V, Cr, Mn, Fe, and Ni and electronic transitions for the gaseous monosulfides of V, Cr, and Fe were observed in Ar and OCS matrices. All infrared frequencies were observed between 500 and 600 cm^{-1}. The sulfide force constants (K/sub ms/) were found to be related to those of the isoelectronic oxide (K/sub mo/) by the equation D/sub mo/K/sub ms//D/sub ms/K/sub mo/ ≈ 0.769, where D is the dissociation energy. A schematic MO diagram is presented which explains the observed trends in the dissociation energies and the force constants. (10 tables,13 fig) (auth)

3573 Moessbauer study of rare-gas-matrix isolated ^{125}Te dimers, $^{125}TeF_6$, and $^{125}TeCl_4$ molecules. Barrett, P.H. (Univ. of California, Santa Barbara); Montano, P.A.; Micklitz, H.; Mann, J.B. *Phys. Rev., B;* 12: No. 5, 1676-1680(1 Sep 1975).

The Moessbauer absorption spectra of $^{125}TeF_6$, $^{125}TeCl_4$, and $^{125}Te_2$ molecules isolated in rare-gas matrices were measured at 4.2°K. The matrix-isolated TeF_6, $TeCl_4$, and Te_2 molecules have isomer shifts of -(1.54 +- 0.05), (1.0 +- 0.1), and +(0.34 +- 0.07)mm/s relative to the Cu-^{125}Sb source, respectively. The Te_2 spectrum shows a quadrupole splitting (QS) of 9.60 +- 0.07 mm/sec, which contains a small asymmetry that is interpreted as an anisotropy in the Debye--Waller factor. Matrix-isolated $TeCl_4$ shows an unresolved QS of 3.5 +- 0.1 mm/s. Results of Dirac--Fock calculations of electron densities at the nucleus in free atoms and ions of tellurium are given. These densities are combined with the measured isomer shifts to calculate the change in the mean-square nuclear-charge radius, $\Delta\langle r^2\rangle$. Values ranging from $\Delta\langle r^2\rangle = (2.0 +- 0.4) \times 10^{-3}$ fm^2 to $\Delta\langle r^2\rangle = (3.4 +- 0.7) \times 10^{-3}$ fm^2 result depending on the assumption of the electron configuration of tellurium in TeF_6. (auth)

3574 Intrinsic acid-base properties of molecules. Binding energies of Li^+ to π- and n-donor bases. Staley, R.H.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.*; 97: No. 20, 5920-5921(1 Oct 1975).

A report is given on the determination of the binding energies of 30 π- and n-donor bases to the reference acid Li^+ (eq 2) and the comparison of two scales of molecular basicity afforded by these results. BH^+ yields B + H^+; ΔH = D(B-H^+) identical with PA(B) (1); BLi^+ yields B + Li^+; ΔH = D(B-Li^+) (2). (JGB)

3575 Synthesis of stable homopolyatomic anions of antimony, bismuth, tin, and lead. The crystal structure of a salt containing the heptaantimonide(3-) anion. Corbett, J.D.; Adolphson, D.G.; Merryman, D.J.; Edwards, P.A.; Armatis, F.J. (Iowa State Univ., Ames). *J. Am. Chem. Soc.*; 97: No. 21, 6267-6268(15 Oct 1975).

A general route to the isolation of stable derivatives of the polyatomic anions of the heavy post-transition metals that have long been known primarily as solutions of the corresponding alkali metal intermetallic phases in liquid ammonia is reported. The method utilizes the strong complexing ability of 2,2,2-crypt for the cation to prevent the usual decomposition reactions wherein electrons from the polyanions are partially transferred back to tha alkali metal to form the parent alloy. In all cases reported here a solution of crypt in ethylenediamine was found to readily react with the appropriate alloy phase to yield a highly colored solution from which a crystalline derivative can be isolated. X-ray data were obtained on a single crystal of the polyantimony derivative. (JGB)

ISOTOPE EXCHANGE AND ISOTOPE SEPARATION

3576 (UCRL-Trans—10948) **Distribution of stable isotopes along an infinitely long separation tube with an infinitely large reservoir at the end, in the stationary condition.** Lyubimov, V.N. Translated from *Isotopenpraxis;* 11: No. 1, 25-29(1975). 15p. Dep. NTIS $4.50.

Using the computer, curves of the distribution of concentrations of isotopes of 17 elements in the stationary condition along an infinitely long separation tube with an infinitely large reservoir at the end were calculated. Distribution curves are presented for polyisotopic elements. Extreme points of the curves are compared. The character of the distribution curves is determined primarily by the initial isotope composition of the element being separated. (auth)

3577 (LA-tr—75-30) **Direct observation of nonequilibrium excitation of high vibrational levels of the OsO_4 molecule excited by a powerful CO_2 laser pulse and osmium isotope separation.** Ambartsumian, R.V.; Gorokhov, Iu. A.; Letokhov, V.S.; Makarov, G.N. Translated by A.D. Cernicek from *Zh. Eksp. Teor. Fiz., Pis'ma Red.*; 22: 96-100(1975). 9p. Dep. NTIS $4.50.

Nonequilibrium population of vibrational levels V greater than or equal to 10 was observed from the change of the vibrational structure of the ultraviolet spectrum of OsO_4 excited by a powerful CO_2 laser pulse. A 15 percent enrichment of osmium isotopes was obtained under the action of the strong infrared radiation field. (auth)

ORGANIC CHEMISTRY

CHEMICAL AND PHYSICOCHEMICAL PROPERTIES

3578 (MHSMP—75-24A) **LX-13 processing. Period covered: April—June 1975.** Stallings, T.L.; Osborn, A.G.; Adams, J.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 7p. Dep. NTIS $4.50.

PETN batches were made from thermally recrystallized PETN. The PETN is to be formulated into LX-13 and tested for extrudability and detonability. Preliminary surface area data appear to indicate a desirable product. (auth)

3579 (MHSMP—75-24B) **Long-term compatibility of Adiprene L-315 and Conap EN-8 with LX-13 and Extex. Period covered: April—June 1975.** Foster, P.A. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 8p. Dep. NTIS $4.50.

A compatibility study of Adiprene L-315 and Conap EN-8 with LX-13 and Extex has been completed. This study covered a period of 1 year at a temperature of 80°C, and all materials were deemed compatible on the basis of the amounts of gas evolved during aging. (auth)

3580 (MHSMP—75-24C) **TATB synthesis activities. Period covered: April—June 1975.** Quinlin, W.T.; Evans, V.H.; Estes, Z.L.; Schaffer, C.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 7p. Dep. NTIS $4.50.

During the last quarter of FY 75, 1030 kg (2266 lb) of symtrichlorotrinitrobenzene (TCTNB) and 712 kg (1566 lbs) of symtriaminotrinitrobenzene (TATB) were produced. Five bench-scale pipe aminations were run. Also, an attempt was made to wash TATB with a high organic chlorine content in order to improve its purity. (auth)

3581 (MHSMP—75-24D) **TATB PBX formulations. Period covered: April—June 1975.** Johnson, H.D.; Osborn, A.G.; Stallings, T.L. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 10p. Dep. NTIS $4.50.

The production of TATB PBX was continued. Included have been the blending of LLL B6 and B7 TATB lots, reprocessing machine tailings and studies of processing parameters. Physical properties of the large PBX lots continued to improve. The LLL B5 PBX has superior physical properties to previous lots and preliminary data obtained on LLL B6 PBX indicate that its tensile properties are superior to LLL B5 PBX. (auth)

3582 (MHSMP—75-24E) **Mechanical properties of TATB/Kel-F 800 formulations. Period covered: April—June 1975.** Johnson, H.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 43p. Dep. NTIS $5.00.

Dimensional stability tests were performed on fifteen batches of TATB/Kel-F 800 PBX formulations. The range of dimensional growth of the formulations tested was 3 to 5 mm/m. The coarse TATB distribution produced the smallest dimensional change after twenty thermal cycles. The mechanical properties of TATB/Kel-F Blend 6 appears to be superior to all blends formulated to date. (auth)

3583 (MHSMP—75-24G) **TATB sensitivity and performance testing. Period covered: April—June 1975.** Kramer, P.E. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 7p. Dep. NTIS $4.50.

Gap tests were conducted to examine the effect of particle size distribution on the sensitivity of RX-03-BB, a chemical explosive consisting of approximately 92.5 percent TATB (1,3,5-triamino-2,4,6-trinitrobenzene) and 7.5 percent Kel-F(a plastic binder). No significant effect other than that attributable to density was observed. A gap test conducted on RX-03-BB at high temperature (74°C) showed increased sensitivity, but most of the change could be attributed to decreased density. The ambient temperature wedge test series with RX-03-BB at 1.896 Mg/m^3 was

completed. Another ambient series at 1.813 Mg/m³ was also conducted. Two wedge tests with RX-03-BB(rho = 1.900 Mg/m³) were fired at -43.5°C. A definite decrease in sensitivity was observed; the change may have been greater than expected from density considerations alone. Attempts to conduct similar tests at 74°C met with difficulties. (auth)

3584 (MHSMP—75-24R) **LX-10 pressing studies. Period covered: April—June 1975.** Harrell, J.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 4p. Dep. NTIS $4.50.

Ten billets of LX-10, a plastic-bonded chemical explosive, were pressed to determine density as a function of the number of compaction cycles. Two techniques, wet-bag and captive water, were considered with repeated applications of compacting cycles, sequenced to be compatible with production equipment. It was found that multiple compacting cycles are required to obtain a density greater than 1.855 Mg/m³. (JGB)

3585 (MHSMP—75-36A) **Thermal properties. Period covered, April—June 1975.** Myers, L.C. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173--AMC-487(A). 14p. Dep. NTIS $4.50.

For Lawrence Livermore Lab., CA.

Chemical reactivity test data are reported which indicate a correlation between the volume of gas evolved by PBX 9404, a plastic-bonded chemical explosive, and (1) the sample holder, (2) the order in which the samples are run and/or the position the samples are conditioned in the oil bath. Runs were also made on samples that were immersed 63.5 and 76.2 mm into the bath. Thermal decomposition data are given for PETN, pentaerythritol tetranitrate, which show its reaction mechanism to be dependent on temperature and/or the extent of the reaction. Activation energies of 6000 and 980 joule/mole (22 and 4 kcal/mole) were calculated from the data. (auth)

3586 Sensitive apparatus for obtaining freezing curves. Purity of 4-aminopyridine. Kroeger, F.R.; Swenson, C.A.; Hoyle, W.C.; Diehl, H. (Ames Lab., IA). *Talanta;* **22**: 641-647(1975).

Freezing curves of highly-purified 4-aminopyridine have been obtained with an instrument of new design employing a gold crucible, a platinum resistance thermometer, electrical heating elements on crucible and heat shield, and accessory electrical control devices such that the temperature difference between crucible and shield could be maintained constant within 0.005° while the temperature of the 4-aminopyridine and crucible dropped through the freezing range. No stirring was used. Methods were devised for handling the data as the derivative of temperature with respect to time and of correcting the freezing curve for the heat capacity of the crucible and charge. Although interpretation of the freezing curves obtained on the 4-aminopyridine was confused by attack on the gold by the molten 4-aminopyridine, the initial impurity in the 4-aminopyridine was probably less than the detection limit, 0.001 mole percent. (auth)

3587 Thermal and thermoxidative stability of polycarbon anyleneperfluorophenylenes. Arnold, C. Jr. (Sandia Labs., Albuquerque, NM). *J. Polymer Sci., Polym. Chem. Ed.;* **13**: No. 2, 517-520(Feb 1975).

Thermogravimetric analysis (TGA) was performed on o- and m-carboranyleneperfluorophenylene polymers to determine if this polymer is more stable than the analogous p-xylylene counterparts. The order of stability was found to be: poly-o(carboranyleneperfluorophenylene poly-m(carboranyleneperfluorophenylene > poly-m-carboranylene-p-xylylene. (JGB)

3588 Molecular dynamics of octane in a gas liquid solution. Assink, R.A. (Sandia Labs., Albuquerque, NM). *J. Chem. Phys.;* **62**: No. 3, 790-794(1 Feb 1975).

A gas/liquid solution was formed by applying up to 70 (MPa) of argon to n-octane. The molecular dynamics of octane in the solution were measured by NMR relaxation techniques. A relatively insoluble gas, helium, was also applied so that the effect of pressure could be contrasted with the effect of solution. The transport properties of octane compressed by argon possessed two distinguishing features. First, the behavior of its diffusion constant indicated that the viscosity of the fluid decreased with pressure as more argon dissolved into the liquid. Second, the pressure dependence of octane's over-all rotational correlation time was much less than the estimated pressure dependence of the solution's viscosity. This latter feature could be explained by a microviscosity theory which takes into account the effect of solvent size on the coupling between molecular rotation and viscosity. (auth)

3589 Pentaerythritol tetranitrate II: its crystal structure and transformation to PETN I: an algorithm for refinement of crystal structures with poor data. Cady, H.H.; Larson, A.C. (Los Alamos Scientific Lab., NM). *Acta Crystallogr., Sect. B;* **B31**: 1864-1869(Jul 1975).

The crystal structure of the high-temperature polymorph of pentaerythritol tetranitrate ($C_5H_8N_4O_{12}$) has been determined from the intensity data on one rotation photograph. PETN II crystallizes in space group Pcnb (a = 13.29, b = 13.49, and c = 6.83 A) with four molecules per unit cell and a calculated density of 1.72 g cm^{-3} at 136°C. The intensity data are insufficient for a normal structure determination so that bond distance and angle information from the structure of PETN I and repulsion terms were included as constraints in the least-squares refinement. The geometries of the PETN molecules in PETN I and II are nearly identical. A mechanism is proposed for the observed PETN II to PETN I transformation that accounts for the observed rates of transformation, low activation energy, and correlation between the structures of the polymorphs. The authors believe that this refinement algorithm has great potential for the refinement of crystal structures from powder data when the molecular structure is known. (auth)

3590 Neutron diffraction study of L-cysteine. Kerr, K.A. (Univ. of Calgary, Alberta); Ashmore, J.P.; Kotzle, T.F. *Acta Crystallogr., Sect. B;* **B31**: 2022(Aug 1975).

The orthorhombic form of L-cysteine, $C_3H_7NO_2S$, crystallizes in space group $P2_12_12_1$ with four molecules in a unit cell of dimensions a = 8.116 (3), b = 12.185 (4), and c = 5.426 (2) A. A three dimensional neutron diffraction study has provided a more precise description of the hydrogen bonds than was possible in the x-ray experiment. In addition, the neutron study has confirmed that the disordered thiol group is involved in to two short contacts, one to oxygen and the other to sulfur. The disorder can be modeled as involving only the hydrogen of the thiol group, or as involving both hydrogen and sulfur. Parameters resulting from both models are presented. (auth)

3591 Medium independent Duschinsky rotation in the S_1 state of the azaazulenes and azulene. Burke, F.P.; Eslinger, D.R.; Small, G.J. (Ames Lab., IA). *J. Chem. Phys.;* **63**: No. 3, 1309-1310(1 Aug 1975).

That the S_1 states of certain azaazulenes and azulene, itself, are subject to the medium independent Duschinsky effect is demonstrated. Some implications of this finding for S_2 of azulene are discussed. (LK)

3592 Photoelectron spectra of carbonyls. Oxamide, parabanic acid, and their N-methyl derivatives. Meeks, J.L.; McGlynn, S.P. (Louisiana State Univ., Baton Rouge). *J. Am. Chem. Soc.;* **97**: No. 18, 5079-5083(3 Sep 1975).

Photoelectron spectra are reported for parabanic acid, three of its N-alkyl derivatives, and three N-alkyl derivatives of oxamide. The spectrum of parabanic acid is assigned using a composite molecule model based on a fragmentation into urea and/or cis-oxamide. The effects of N-methylation are discussed and used to differentiate various types of ionization events. (auth)

3593 Exciplex and triplex emission in the system 9,10-dichloroanthracene—2,5-dimethyl-2,4-hexadiene. Saltiel, J.; Townsend, D.E.; Watson, B.D.; Shannon, P. (Florida State Univ., Tallahassee). *J. Am. Chem. Soc.;* **97**: No. 20, 5688-5695(1 Oct 1975).

Steady-state and transient fluorescence measurements were made using mixtures of 9.10-dichloroanthracene and 2,5-dimethyl-2.4-hexadiene in benzene and acetonitrile. In benzene a fluorescent exciplex, λ/sub max/ ~ 485 mm, tau 7.4 nsec, forms reversibly with an attenuated equilibrium constant for exciplex formation at room temperature of 20 +- 1 M^{-1}. In contrast, no exciplex fluorescence is observed from acetonitrile solutions at intermediate diene concentrations, but triplex fluorescence λ/sub max/ ~ 543 nm and tau 3.6 nsec, is observed at higher diene concentrations. Steady-state fluorescence observations in the presence of air are also described. (auth)

3594 Ion—molecule reactions of NO^+ with organic molecules by ion cyclotron resonance spectroscopy. Williamson, A.D.; Beauchamp, J.L. (California Inst. of Tech., Pasadena). *J. Am. Chem. Soc.;* **97**: No. 20, 5714-5718(1 Oct 1975).

Ion cyclotron resonance techniques are used to study the reaction of NO^+ with various organic molecules in the gas phase. NO^+ reacts with acetaldehyde and isobutane by hydride transfer, yielding CH_3CO^+ and $(CH_3)_3C^+$, respectively. Association of NO^+ with an organic halide RX leads to the formation of a chemically activated species which may dissociate to the reactants or, when exothermic, to a nitrosyl halide XNO and a carbonium ion R^+ (halide transfer). In some cases the intermediate is also observed to eliminate HX to give an alkene, with NO^+ remaining bound to either species in the products. Transfer of NO^+ from these

products to various π- and n-donor bases occurs readily. The activated complex formed by reaction of NO^+ with alcohols does not follow the pattern of the organic halide reactions, but decomposes instead by transfer of OH^- or an alpha hydride to NO^+. The important factor in reactions of NO^+ is its Lewis acid character. (auth)

3595 Absolute configuration of vincoside. Mattes, K.C. (Univ. of Wisconsin, Madison); Hutchinson, C.R.; Springer, J.P.; Clardy, J. *J. Am. Chem. Soc.*; **97**: No. 21, 6270-6271(15 Oct 1975).

X-ray analysis was used to study the stereochemistry of vincoside. A computer generated perspective drawing of the N/sub b/-p-bromobenzyltetraacetylvincoside derivative is given. (JGB)

3596 NMR study of motion in hydrazine sulfate. Harrell, J.W. Jr.; Peterson, E.M. (Physics Department, University of North Dakota, Grand Forks, North Dakota 58201). *J. Chem. Phys.*; **63**: No. 8, 3609-3612(15 Oct 1975).

Proton rotating frame relaxation time (T_1/sub rho/) measurements have been made on hydrozine sulfate from 137 to 495 degreeK, and single crystal deuteron resonance measurements have been made from 297 to 501degreeK. The T_1/sub rho/ measurements exhibit minima at 167 and 315 degreeK and decrease very rapidly above 473 degreeK. The deuteron resonance spectrum is constant up to 483 degreeK and narrows into a single central line above 488 degreeK. The measurements below the phase transition at 481 degreeK are analyzed in terms of NH_3 reorientation and 180 degreeK flips of the $N_2H_6^{++}$ ions. Above the phase transition the measurements are analyzed in terms of translational diffusion of the $N_2H_6^{++}$ ions.

ISOTOPE EFFECTS

3597 Raman spectral study of amorphous solid water. Venkatesh, C.G.; Rice, S.A.; Bates, J.B. (Department of Chemistry and The James Franck Institute, The University of Chicago, Chicago, Illinois 60637). *J. Chem. Phys.*; **63**: No. 3, 1065-1071(1 Aug 1975).

Raman spectra of amorphous solid H_2O, H_2O(as), D_2O(as), and 12% H_2O in D_2O(as) were measured over a temperature range from 30 to 120 degreeK. The spectra of H_2O(as) resemble those of liquid water more than they do those of ice 1c or ice 1h. The spectra suggest that the water molecules are located in two or three types of distinguishable environments depending on the details of the assignment. No structural changes were observed between 30 and 120 degreeK, but at ~160 degreeK the amorphous samples transformed rapidly and irreversibly to ice 1c.

ELECTROCHEMISTRY

3598 (UCRL-Trans—10939) **Theory of the conductivity of strong, nonassociating electrolytes at higher concentrations.** Falkenhagen, H.; Leist, M.; Kelbg, G. Translated from *Ann. Phys. (Leipzig)*; **11**: No. 1, 51-59(1952). 14p. Dep. NTIS $4.50.

Further development of the theory of the conductivity and dielectric constants of strong, univalent-univalent electrolytes makes use of a new distribution function, recently formulated by Eigen and Wicke, which incorporates hydration of the ions, and takes account of the finite ion diameter (i.e., a mean distance up to which the centers of two ions can approach). This new distribution function n/sub iP//sup jQ/, which gives the probability of finding in the vicinity of an i-ion at point P a j-ion at point Q, contains as a new characteristic parameter the occupancy density N/sub j/ of the j-ions in the sense of Eigen and Wicke. The latter have applied their theory to the thermodynamics of activities. They checked the new law describing the activity coefficients as a function of concentration for the univalent-univalent electrolytes NaCl, KCl, RbCl and CsCl and found it to be in quantitative agreement with the experimental data. The logical extension of this theory, as well as its application to the conductivity of the electrolytes NaCl, KBr and RbCl in the stationary state, and its testing by means of measured results, is undertaken in the present study. For these special cases, the theory agrees with the experimental findings up to concentrations of approximately 1 mol per liter solution. (auth)

3599 (ORNL-tr—2955) **Cell Pt,H_2(1 atm)/HBr, Hg_2Br_2(s)/Hg in organic solutions and their mixtures with water. I. Pt,H_2(1 atm)/HBr(m), ethanol (x), H_2O(100-x), Hg_2Br_2/Hg.** Schwabe, K.; Urlass, R.; Ferse, A. Translated by M. Gerrard from *Ber. Bunsenges. Phys. Chem.*; **68**: No. 1, 46-52(1964). 22p. Dep. NTIS $4.50.

E.m.f. measurements on the cell Pt, H_2 (1 atm)/HBr (m), ethanol (x), water (1 - x)/Hg_2Br_2(s)/Hg at 20, 40, 65, 90, and 95 percent ethanol by weight and various molalities (m) of hydrobromic acid have been used to determine the standard emf's for different solvent mixtures, according to several extrapolation procedures, as well as activity coefficients and various medium effects. The results are compared with those obtained in an analogous manner from the cell Pt, H_2 (1 atm.)/HCl (m), ethanol (x), water (1 - x)/Hg_2Cl_2 (s)/Hg. (auth)

PHOTOCHEMISTRY

3600 (LA—6055-MS) **Chemistry computations for irradiated hot air.** Sutherland, C.D.; Zinn, J. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1975. 58p. Dep. NTIS $5.45.

A description is given of a computational model of chemical kinetics in air at temperatures between 300 and 4000°K, with and without imposed fluxes of ionizing radiation and uv radiation, at pressures up to 10 atmospheres. Included are 1360 chemical reactions, involving 71 H, C, N, and O-containing chemical species. The reaction set is complete in the sense of including a reverse reaction for every reaction and including the dominant destruction reactions for each species produced. Photochemical reaction rates are computed in terms of a prescribed intensity and spectral distribution of radiant flux. Reactions of the metastable species $O(^1D)$, $N(^2D)$, $O_2(^1\Delta g)$, and $O_2(^1\Sigma^+$/sub g/) are included explicitly, but all other quantum state populations are assumed to be in thermodynamic equilibrium. Results of several sets of model computations are described. These include: computations of rates of equilibration of systems subjected to abrupt temperature changes at a pressure of 1 atmosphere; computations of relaxation of systems subjected to impulsive sources of ionizing radiation at P = 1 atmosphere and 0.01 atm, with and without superimposed sources of optical-uv radiation; and computations of the approach to steady state in systems subjected to steady sources of ionizing radiation, for pressures between 10^{-3} atm and 10 atm. For computing concentrations of electrons, ions, NO, NO_2, O, N, and O_3, an abbreviated lumped-parameter reaction set was constructed with 31 reactions, designed to be incorporated in a fluid-dynamics code. Rate coefficients were calibrated against results from the 1360-reaction code for temperatures between 300 and 4000°K and pressures between 10^{-3} and 10 atm. (auth)

3601 Fluorescence of mono-olefinic hydrocarbons. Hirayama, F.; Lipsky, S. (Univ. of Minnesota, Minneapolis). *J. Chem. Phys.*; **62**: No. 2, 576-583(15 Jan 1975).

A weak fluorescence has been observed from propylene, 1-butene,cis-2-butene, trans-2-butene, 1-hexene, cis-2-hexene, trans-2-hexene, 2-methyl-2-pentene, and 2,3-dimethyl-2-butene excited at 184.9 nm in vapor and/or liquid phases. Emission spectra and emission quantum yields are reported. For 2,3-dimethyl-2-butene (tetramethylethylene) the emission intensity was sufficiently strong to permit more detailed study of its properties, and accordingly the effect of longer wavelength excitation, the effectiveness of CCl_4 and O_2 as quenchers, and the effect of solution in low-temperature hydrocarbon matrices are additionally reported. Possible assignments for the olefin emissions are discussed. (auth)

3602 Photoionization quantum yields. A convenient 147 nm actionometer. Salomon, D.; Scala, A.A. (Worcester Polytechnic Inst., MA). *J. Chem. Phys.*; **62**: No. 4, 1469-1472(15 Feb 1975).

The photoionization quantum yields of trimethylamine, triethylamine, dipropylamine, di-iso-propylamine, and tetramethylene sulfide have been determined, at 147 nm, to be 0.38, 0.46, 0.096, 0.15, and 0.10, respectively. These ionization efficiencies permit actinometry based upon saturation current measurements. This physical technique of absolute photon flux measurement is contrasted with the chemical actinometers currently in use at 147 nm. (auth)

3603 Temperature dependence of the recombination fluorescence of photoionized tryptophan in aqueous glasses: consequences of electron tunneling. Moan, J. (Norsk Hydro's Inst. for Cancer Research, Oslo); Ho, K.K.; Kevan, L. *J. Chem. Phys.*; **63**: No. 3, 1285-1288(1 Aug 1975).

The recombination fluorescence seen when tryptophan in ethylene glycol/water and 9M LiCl frozen aqueous glasses is photoionized has been investigated. It is found that the intensity as well as the initial decay rate of this recombination fluorescence decreases as the uv irradiation temperature increases from 77 K. This is interpreted in terms of a tunneling process in which the electron trap depth increases slightly with increasing irradiation temperature. This causes the tunneling rate constant to decrease, and as the trap depth drops below the lowest singlet level of tryptophan, an increasing fraction of the recombination events will lack the energy necessary to generate recombination fluorescence. (auth)

RADIATION CHEMISTRY

3604 (COO—958-52) **Properties of solvated electrons and associated species in metal solutions and kinetics of electron- and proton-transfer reactions. Progress report, 16 September 1974—15 September 1975.** Dye, J.L. (Michigan State Univ., East Lansing (USA). Dept. of Chemistry). Sep 1975. Contract E(11-1)-958. 23p. Dep. NTIS $4.25.

The formation of salts of alkali metal anions has been shown to be a general phenomenon under suitable conditions. Solutions which contain Na^-, Rb^- and Cs^- have been identified by the use of alkali metal NMR techniques. Measurements of the rate of exchange of M^+ between crown and cryptate complexes and the solvated cation have been measured for Li^+, Na^+ and Cs^+. Preliminary measurements of the rate of alkali metal exchange between NaC^+ and Na^- have been made with 18-Crown-6 as the complexing agent. The role of solvated electrons as intermediates has been examined. Studies of the properties of solid compounds which contain M^- and/or e^- have been continued. Gold-colored solids have been obtained for Na, K, Rb and Cs by solvent evaporation from a solution which contains the metal plus a complexing agent of either the crown or cryptand class. In the former case, solvent is present in the solid and is necessary for its stabilization. (auth)

3605 (COO—1763-48) **Pulse radiolysis studies of fast reactions in molecular systems. Progress report, November 1974—October 1975.** Dorfman, L.M. (Ohio State Univ. Research Foundation, Columbus (USA)). 1975. Contract AT(11-1)-1763. 8p. Dep. NTIS $4.50.

Work on the reactivity of aryl carbonium ions in solution and single heme reduction in human methemoglobin is summarized. (LK)

3606 (COO—3238-534) **Quarterly report, April 1, 1975—June 30, 1975.** (Mellon Inst. of Science, Pittsburgh (USA). Radiation Research Labs.). 3 Jul 1975. Contract AT(11-1)-3238. 22p. Dep. NTIS $4.50.

Status of the following studies is given: ESR study of dissociation of NH protons of peptide radicals; electron transfer from ascorbate anion to phenoxyl radicals; dehydrohalogenation of halophenols by OH; reaction of OH radicals with nitroheterocyclic compounds; pulse radiolysis studies of the oxidation of N,N-dimethylaniline in aqueous solution; pulse radiolysis studies of some reactions of bromine dioxide in aqueous solutions; and application of radio-liquid chromatography to the radiolysis of aqueous benzene solutions. Abstracts of reports published during the quarter ending June 30, 1975 are included. (LK)

3607 (ORO—4183-22) **Chemical effects of ionizing radiations on the individual amino acids within intact and pure protein molecules. Comprehensive and renewal report.** Friedberg, F. (Howard Univ., Washington, D.C. (USA)). 1975. Contract AT(40-1)-4183. 10p. Dep. NTIS $4.50.

Status of the following studies is reported: effect of gamma radiation on polypeptides, ribonuclease, solid ribonuclease, polyamino acids in the solid state, solid ATP creatine phosphotransferase and gelatin, lyophilized proteins, solid proteins; acetic and proprionic acid production from gamma irradiated dry proteins; covalent binding of amino acids to proteins due to gamma irradiation; effects of metal ions on the formation of chain breaks and radicals in gamma irradiated collagen and polyadenylic acid; and sensitivity of gelatin and albumin to irradiation at 230 nm. (LC)

3608 (SAND—75-0435) **Beneficial Uses program. Progress report [for] period ending June 30, 1975.** (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 80p. Dep. NTIS $5.45.

Status of the following programs is reported: waste resources utilization program; beneficial uses of radioisotopic waste program; and biomedical and environmental support programs. Three items were abstracted separately. (LK)

3609 **Synthesis and γ-irradiation of verbenone and verbenol.** Kulesza, J.; Tsankova, E.; Gora, J. (Technical Univ., Lodz, Poland). *An. Acad. Bras. Cienc.*; **44**: 408-411(1972).

Verbenone and verbenol which can be obtained by catalytic oxidation of α-pinene, are very useful for the perfumery industry. They can be used directly in perfume compositions or for the production of a number of other perfumery synthetics. The authors have attempted to transform verbenol and verbenone into other compounds by gamma irradiation. It was found, that verbenone exhibits resistance to the gamma irradiation and even at the doses of 500 Mrad it was only with small yield transformed in chrysantenone. The gamma irradiation of cis and trans verbenol by the doses of 220 Mrad has showed no change in the case of trans isomer, and on the other hand the cis isomer was transformed mainly into trans verbenol and verbenone. The results of the investigation of the conditions having influence on the yield and the composition of the reaction products in the process of the catalytic oxidizing of α-pinene are given. (auth)

3610 **Decay mechanisms of CH_3 in 3-methylpentane and 3MP-d_{14} glasses at 77 °K as indicated by methane yields.** Neiss, M.A.; Sprague, E.D.; Willard, J.E. (Department of Chemistry, University of Wisconsin, Madison, Wisconsin 53706). *J. Chem. Phys.*; **63**: No. 3, 1118-1121(1 Aug 1975).

The isotopic methane yields from γ irradiation of 3-methylpentane, 3MP—1%CH_3I, 3MP-d_{14}—1%CH_3I, and 3MP-d_{14}—1%CD_3 glasses confirm recent evidence from decay kinetics that thermal CH_3 radicals can abstract H from C—H bonds in hydrocarbon glasses at 77degreeK (plausibly by tunneling) and show that similar abstraction does not occur from C—D bonds. Also, in 3MP-d_{14} the CH_3 (formed by the CH_3I+e^- yields CH_3+H^- process) does not decay by radical combination processes (CH_3+CH_3 or $CH_3+C_6D_{13}$), implying that decay is by geminate recombination with the I^- partner. In the γ irradiation of 3MP-d_{14}—1%CH_3 irradiated at 77degreeK, G (CH D) from hot abstraction by CH_3 is 0.7; thermal CH_3 and CD_3 radicals are able to abstract H from low concentrations of C—H bond isotopic impurities; and the yields of scavengeable electrons and of radicals are substantially different than in 3MP-h_{14}.

3611 **Yield of singlet and triplet excitons from x-ray and ruby laser excitation of anthracene single crystals.** Hughes, R.C.; Soos, Z.G. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Chem. Phys.*; **63**: No. 3, 1122-1126(1 Aug 1975).

A new method for determining the singlet:triplet yields for x-ray and ruby laser excited anthracene crystals is described. It was found that the ratio is higher than has been reported for x-ray excitation and lower than reported for ruby laser excitation. X-ray excitation produces roughly equal numbers of triplets and singlets. Ruby laser excitation indicates that the intersystem crossing rate from the first excited singlet is 1.5plus-or-minus0.5times10^7 sec^{-1}, which is larger than had been reported, but still smaller than for anthracene molecules in solution. The greater triplet yield produced by x irradiation is related to efficient spin—lattice relaxation in highly excited electronic states and neither spin—spin nor spin—lattice relaxation in the electron and hole ground states is important in the short time involved in geminate recombination.

3612 **One-electron reduction potential of riboflavine studied by pulse radiolysis.** Meisel, D.; Neta, P. (Carnegie-Mellon Univ., Pittsburgh). *J. Phys. Chem.*; **79**: No. 23, 2459-2461(6 Nov 1975).

The one-electron reduction potential of riboflavine was determined at several pH values between 6 and 12 using the pulse radiolysis technique. Irradiation was carried out using 2.8-MeV electrons from a Van de Graaff accelerator. Solutions containing riboflavine and either duroquinone or 9,10-anthraquinone-2-sulfonic acid were irradiated under reducing conditions to produce their semiquinoidic radicals. Electron transfer from one of the radicals to the parent molecule of the other then took place until equilibrium was achieved. Spectrophotometric measurement of radical concentrations at equilibrium enabled determination of the equilibrium constant and redox potential. The reduction potential of riboflavine at pH 7 was found to be $E_7^1 = -0.292 +- 0.005$ V. The dependence of the reduction potential of riboflavine on pH was found to be in agreement with the dependence expected from the known pK values for riboflavine and its semireduced form. (auth)

RADIOCHEMISTRY AND NUCLEAR CHEMISTRY

PROPERTIES OF RADIOACTIVE MATERIALS

3613 (BNWL-SA—5514) **Harmon, K.M.** PNL studies of D and D at Hanford. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 20p. (CONF-750822—8). Dep. NTIS $4.00.

From 14. international conference on low temperature physics; Otaniemi, Finland (14 Aug 1975).

The PNL decontamination and decommissioning program at Hanford involves (1) the preparation of a long-term plan for a systematic approach to the extensive and varied programs of decommissioning retired facilities at Hanford and (2) a D and D demonstration project, the decommissioning of a grossly contaminated plutonium processing facility. (auth)

3614 (ORO—4447-029) **Study of the oxidation-reduction kinetics involved in the Np(V) + Fe(II) in equilibrium Np(IV) + Fe(III) system in nitric acid solutions.** Jao, Y. (Tennessee Univ., Knoxville (USA)). Aug 1975. 62p. Dep. NTIS $6.25.

Thesis.

Ferrous nitrate-hydrazine is one of the more attractive alternate reactants to the currently used reagent, ferrous sulfamate, for partitioning plutonium from neptunium and uranium. An understanding of the kinetics of the reduction of Np(VI) to Np(IV) by ferrous nitrate-hydrazine is needed before a satisfactory evaluation of the feasibility of this reductant in actinide element separations can be made. The purpose of this work was to study the kinetics and mechanisms of the reduction of Np(V) by Fe(II) and the oxidation of Np(IV) by Fe(III) in 1-2 M nitric acid solutions. The acid concentration range was chosen to include that typically used in the separation of plutonium from neptunium and uranium by solvent extraction with tributylphosphate. The forward and reverse rate constants, hydrogen ion dependence, temperature dependence, ionic strength effects and nitrate ion influence were determined. The proposed reaction mechanisms involve protonation of the NpO_2^+ ions and hydroxyoxygenation of Np^{4+} ions. (LK)

3615 (UCRL—76708) **Estimated values of some cryogenic properties of hydrogen isotopes.** Briggs, C.K.; Hickman, R.G.; Tsugawa, R.T.; Souers, P.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Sep 1975. 11p. (CONF-751026—4). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The literature on cryogenic hydrogen isotopes from 4.2 to 25°K is reviewed for triple points, vapor pressures, liquid viscosities, surface tensions, and liquid and solid densities. Data are extrapolated to yield values for DT. Empirical equations are given for all isotopes for each property. At the estimated 19.71°K triple point of 1:1 D-T in D_2-DT-T_2 solution, the estimated properties are: vapor pressure, 19,420 Pa (145.7 torr); viscosity 550 x 10^{-7} Pa.s; surface tension 4.23 x 10^{-3} N/m; liquid density, 0.0446 x 10^6 mol/m³ (224 Kg/m³); solid density, 0.051 x 10^6 mol/m³ (256 Kg/m³); and shrinkage upon freezing, -13 vol percent. At 4.2°K, estimated values are: vapor pressure, 2.4 x 10^{-10} Pa (1.8 x 10^{-12} torr) and solid density, 0.053 x 10^6 mol/m³ (267 Kg/m³). (auth)

3616 (UVA-ER—001-75U) **Measurement of the gas density of uranium hexafluoride by laser Raman scattering.** Adolfson, W.F.; Schlecht, R.G.; Morton, J.B. (Virginia Univ., Charlottesville (USA). Research Labs. for the Engineering Sciences). Jul 1975. Contract E(40-1)-1779. 64p. Dep. NTIS $6.25.

This investigation demonstrates the feasibility of using laser Raman scattered light to measure the gas density of uranium hexafluoride over the pressure range 1-72 Torr. Light scattered at right angles from the laser beam is collected by a lens arrangement, analyzed with a monochromator, and recorded with a dc amplifier and photomultiplier system. A review of the pertinent concepts describing the Raman effect is presented, and the sources of background, of which dark current was the most significant, are discussed. The first fundamental vibrational frequency of UF_6 is located at 665 cm^{-1}, and had a 2.5 cm^{-1} linewidth (FWHM) and 0.024 depolarization ratio. The peak differential cross section of this line, measured relative to the 992 cm^{-1} line of benzene, is 1.2 x 10^{-29} +- 9 percent cm^2/mol. sr. cm^{-1}. The intensity of the scattered light remains linear over one and one-half orders of magnitude. Detection was limited in the low light levels by the detector dark current. (auth)

3617 **Heat capacities of $^{242}PuF_3$ and $^{242}PuF_4$ from 10 to 350 K, and of $^{244}PuO_2$ from 4 to 25 K: derived entropies and other thermodynamic properties at 298.15 K.** Flotow, H.E.; Osborne, D.W.; Fried, S.M.; Malm, J.G. (Argonne National Lab., IL). pp 477-488 of In Thermodynamics of nuclear materials, 1974. Volume II. Vienna; International Atomic Energy Agency (1975).

From Symposium on thermodynamics of nuclear materials; Vienna, Austria (21 Oct 1974).

See STI/PUB—380(Vol.2); CONF-741030—P2.

The heat capacities of $^{242}PuF_3$ and $^{242}PuF_4$ have been determined from 20 to 350°K by the quasi-adiabatic method with intermittent electrical heating. From 18 to 58°K the measured temperature drifts with no electrical heating were compared with the measured heat capacities to evaluate the radioactive self-heating rate, (1.210 +- 0.004) x 10^{-4} W/g Pu. Heat capacities between 10 and 20°K were determined from the radioactive self-heating rate and temperature drifts with no electrical heating. The data for $^{242}PuF_3$ showed a transition, believed to be non-magnetic in origin, in the region of 119°K. Magnetic susceptibility measurements indicate that $^{242}PuF_3$ becomes antiferromagnetic below about 9°K. The results for $^{242}PuF_4$ showed no anomalous effects. The heat capacity of $^{244}PuO_2$ has been obtained between 10 and 25°K by the intermittent electrical heating technique. No thermal anomaly was detected from 4 to 25°K. Evidence for a slight amount of radiation crystal damage was detected for $^{242}PuF_3$ after holding its temperature below 9°K overnight. $^{242}PuF_4$ and $^{244}PuO_2$ showed no radiation damage effects. Heat capacities and derived entropies, enthalpies and Gibbs energies divided by temperature are presented in tabular form at selected temperatures to 350°K. Comparisons of these data with other data and estimates in the literature are made. (auth)

3618 **Reaction of thorium and $ThCl_4$ with UO_2 and $(Th, U)O_2$ in fused chloride salts.** Chiotti, P.; Jha, M.C.; Tschetter, M.J. (Ames Lab., Iowa). Contract W-7405-eng-82. *J. Less-Common Met.*; **42**: No. 2, 141-161(Sep 1975).

An experimental and theoretical investigation of the reactions of thorium and $ThCl_4$ with UO_2 and $(Th,U)O_2$ in fused KCl—LiCl and NaCl—$MgCl_2$ eutectic salts has been carried out. The equilibrium $ThCl_4 + ThO_2$ reversible $2ThOCl_2$ has been considered in some detail and the maximum solubility of $ThOCl_2$ as a function of the $ThCl_4$ concentration in KCl—LiCl calculated. The activity coefficient of $ThOCl_2$ was estimated from experimental data. Similar calculations were made for the solubility of $UOCl_2$. The reaction of $ThCl_4$ with UO_2 involves three independent reactions. The equilibrium concentration of components in KCl—LiCl salt for the overall reaction Th + UO_2 yields ThO_2 + U can be described in terms of two independent reactions, and the experimental data are consistent with available thermodynamic data. The reduction of UO_2 and $(Th,U)O_2$ to produce uranium and ThO_2 has been demonstrated. Methods for separating the uranium from the ThO_2 precipitate are considered briefly. (auth)

RADIOISOTOPE PRODUCTION

3619 **Historical sketch of the discovery, production, and application of radioisotopes.** Williams, C. (Brookhaven National Lab., Upton, NY). *Nucl. Technol.*; **27**: No. 1, 119-123(Sep 1975).

The Joliot-Curies made the first artificial radioisotope (^{30}P) by bombarding aluminum with alpha particles. The development of the cyclotron and other high-energy particle accelerators in the early 1930's led to the production of numerous radioisotopes in measurable quantities. By the beginning of the 1950's, with the abundant neutron fluxes available at the U. S. Atomic Commission reactors, radioisotopes of many species really became abundant. Naturally occurring radioactive lead had been used very sparingly as tracers as far back as 1918 in determining chemical solubility and in 1923 in plant uptake from lead solutions. Now many new uses were developed and tested as tracers in medical diagnosis, agricultural, and industrial chemical and metallurgical processes. Many therapeutic applications were tested. The industrial labs developed thickness and level gauges for control of various manufacturing processes. Cobalt gamma-ray irradiators were developed for medical therapy and have also been used for sterilization of surgical instruments and materials, for food preservation, and for initiation of certain chemical reactions. The most significant development in the 1960's was the rapidly increasing role of private industry in taking over the development, production, sales, as well as research, into new methods of production and applications of radioisotopes. (auth)

ENGINEERING

GENERAL ENGINEERING

3620 (AECL—4925) **SI conversion of some steel construction tables.** Head, D.A.; Fundytus, D.; Smith, D.W.R. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Jul 1975. 40p. Dep. NTIS (US Sales Only) $5.00. AECL $1.00.

This report consists of tables of data in SI units for various forms of construction steel. It was derived by soft conversion of "Steel Construction", 5th Ed., American Institute of Steel Construction, New York, 1957, pp 12-46. The report is one of a series of conversions of useful engineering source data and standards. (auth)

3621 (MHSMP—75-12A) **Design of a study to investigate the reliability of preventive maintenance standard times.** Walsh, J.M. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 15 Jan 1975. Contract DA-11-173-AMC-487(A). 40p. Dep. NTIS $5.00.

The purpose of this study design proposal is to solicit managements' approval of the costs required to determine the accuracy of the estimated times and to provide documentation concerning the techniques that will be employed in the investigation. (auth)

FACILITIES AND EQUIPMENT

3622 (BDX—613-1303(Rev.1)) **Burrs produced by side-milling cutters. Topical report.** Gillespie, L.K. (Bendix Corp., Kansas City, Mo. (USA)). Nov 1975. Contract AT(29-1)-613. 48p. Dep. NTIS $4.00.

Small precision mechanisms such as timers, switches, and actuators require burr-free, sharp-edged parts to operate well. This study indicated that the smallest edge-radius which can be reliably produced by skilled operators, while deburring with hand tools, is 0.004 in. (101.6 μm). Fifty percent of the radii produced while trying to maintain a 0.002 in. (50.8 μm) maximum edge-radius were 0.002 in. or smaller. Hand-deburring time increases as burr thickness increases and as accessible space around the burrs decreases. Ten to 60 percent of the time spent in hand deburring precision miniature parts is consumed in checking edges to be sure they are burr-free. Maintaining edge radii requirements on short-run precision miniature parts requires a combination of hand and mechanized deburring on many parts. (auth)

3623 (BDX—613-1319) **Press-fit interference-limit study for miniature assemblies.** Elder, C.W. Jr. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 50p. Dep. NTIS $4.00.

A study was made to determine the effect of press-fit variables on the axial movement of 0.020- and 0.060-in.-dia pins installed in mating collars. Interference limits, the use of lubrication, press-rate, outer diameter of collar, and length of engagement were evaluated. Statistical analysis indicated that the smaller pins were affected more by hole size and surface finish than the larger pins. Lubrication and press-rate had no significant effect upon press-in force or holding-power. A need for improvement in hole-measuring techniques is indicated. Other pin-retention methods are recommended when pin dia are less than 0.060 in. (auth)

3624 (BDX—613-1443) **Hand deburring of precision miniature parts.** Gillespie, L.K. (Bendix Corp., Kansas City, Mo. (USA)). Nov 1975. Contract AT(29-1)-613. 33p. Dep. NTIS $4.00.

Small precision mechanisms, such as timers, switches, and actuators, must have burr-free, sharp-edged parts to operate well. By controlling the size of burrs produced in milling operations, burr removal costs can be lowered, and the repeatability of the edges can be improved. This study indicated that slower feedrates generally resulted in thinner burrs. The eight different burrs, produced by a side-milling cutter in a single cut, all respond differently to changes in cutting conditions. Cutters having a non-zero helix angle produce longer and thicker burrs than those with a zero helix angle. Radial depth of cut did not influence burr size. Full radius keyseat style cutters with Master Cut tooth geometry produced longer and thicker burrs than similar cutters with square tooth corners. Burrs in 17-4 PH stainless steel were much smaller than those in 303 Se stainless steel. A basic explanation of the formation of milling burrs is presented. (auth)

3625 (CEA-N—1796) **CEA-SEMT system, "TEDEL" program: notice of the "plasticity" section. First supplement to the note CEA-N-1751, November 1974.** Hoffmann, A. (CEA Centre d'Etudes Nucleaires de Saclay, 91 - Gif-sur-Yvette (France). Service des Etudes Mecaniques et Thermiques). May 1975. 15p. (In French). Dep. NTIS (US Sales Only) $4.50.

A plasticity model was introduced and is now operational in the TEDEL program (piping and framework). At the moment it allows for either regular loading or cyclic loading under isotropic hardening conditions. The dynamic module allows the study of dynamic-plastic problems (such as accidents on a piping system). It can accept several types of material characterized by tensile curves which may be of any form. Instructions are also given for the use of a new option (variable) by which the displacement values laid down for different load situations may be modified. (auth)

3626 (CEA-R—4682(1)) **Simulation of mechanical shocks environments. Volume 1.** Lalanne, C. (CEA Centre d'Etudes Scientifiques et Techniques d'Aquitaine, 33 - Le Barp (France)). Jul 1975. 470p. (In French). Dep. NTIS (US Sales Only) $26.50.

Shocks can produce a severe mechanical environment which must be taken in account when designing and developing new equipment. After some mathematics, as Laplace and Fourier transforms, and mechanical revivals as response to a one degree of freedom system to a sinusoidal excitation, this paper shows and compares different analysis methods. These methods are used to compare relative severities of tests and to establish specifications. A few chapters are intended to establish different properties of simple, easy to produce shock shapes. Then some now-in-use shock-machine specifications are shown. A final chapter concerns acceleration transducers. (auth)

3627 (CEA-R—4682(2)) **Simulation of mechanical shocks environments. Volume 2.** Lalanne, C. (CEA Centre d'Etudes Scientifiques et Techniques d'Aquitaine, 33 - Le Barp (France)). Jul 1975. 694p. (In French). Dep. NTIS (US Sales Only) $37.75.

Shocks can produce a severe mechanical environment which must be taken in account when designing and developing new equipment. After some mathematics, as Laplace and Fourier transforms, and mechanical revivals as response of a one degree of freedom system to a sinusoidal excitation, this paper shows and compares different analysis methods. These methods are used to compare relative severities of tests and to establish specifications. A few chapters are intended to establish different properties of simple, easy to produce shock shapes. Then some now-in-use shock-machine specifications are shown. A final chapter concerns acceleration transducers. (auth)

3628 (CONF-750860—1) **Review of fault tree analysis with emphasis on limitations.** Fussell, J.B. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 18p. Dep. NTIS $4.50.

From Conference on international federation of automatic control; Cambridge, Massachusetts, USA (24 Aug 1975).

An overview, with references for additional detail, is given for the analyst who wishes to apply the fault tree method for system reliability and safety analysis to industrial situations. The applicability of fault tree analysis and the limitations of such analysis are discussed. The various quantitative measures of system safety and reliability are presented. (auth)

3629 (CONF-750978—1) **Inflation forming of steel fiber reinforced concrete domes.** Batson, G.B.; Naus, D.J.; Williamson, G.R. (Army Construction Engineering Research Lab., Champaign, Ill. (USA)). 1975. 19p. Dep. NTIS $4.00.

From RILEM symposium on fiber-reinforced cement and concrete; London, UK (14 Sep 1975).

The feasibility of inflation forming steel fiber reinforced (FR) concrete shell structures suitable for shelters and fortification is shown to be viable construction method. The technique of construction is based on the experience gained building several 2.75 m (9 ft) dia domes of variable shell thickness. The technique developed is to be used for the construction of 8.5 m (28 ft) dia domes. The preliminary stress analysis for a 8.5 m (28 ft) dia dome of variable thickness using a finite element method showed that the steel FR concrete was not highly stressed for the loads, openings and boundary conditions investigated. The buckling analysis was not completed in time to be included in this report; however, preliminary values are presented. The inflation forming technique has the possibility of reducing the time of construction, man-hours of labor and level of skill needed to construct shelters and fortifications. (auth)

3630 (CONF-751107—6) **Evaluating the profitability of standby components using reliability engineering.** Cox, N.D. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 20p. Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

A method for accounting for the statistical variations in operating times and in repair times during evaluation of the profitability of installing spare components in a process train is outlined. The method is demonstrated for the case of a single installed spare. (auth)

3631 (CONF-751107—13) **New method for forecasting plant maintenance requirements from maintenance records.** Wilson, J.R.; Cox, N.D.; Fussell, J.B.; Clark, J.H.; Dickinson, D.L. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). 1975. 24p. Dep. NTIS $4.50.

From 68. annual meeting of American Institute of Chemical Engineering; Los Angeles, California, USA (16 Nov 1975).

The paper concerns the use of statistical techniques for time series analysis of maintenance histories to predict future requirements. The theoretical aspects of the method are presented and the assumptions made are discussed. An example is given to illustrate the technique. (auth)

3632 (FE—1533-T-2) **Evaluation of coal gas fired ceramic regenerative heat exchanger. Progress reports for the periods, January—April and October 1974.** Cook, C.S. (General Electric Co., Philadelphia, Pa. (USA). Space Div.). 1974. 39p. Dep. NTIS $5.00.

Progress on the construction of the regenerative heat exchanger for closed cycle usage with argon continued. Damage to the replacement bricks in shipping led to further delay. Other modifications in construction had to be made due to design errors or uncertainties. The system was almost complete at the end of the period. (LTN)

3633 (KFK-PDV—38) **Design of man—machine communication systems: basic human factors, demands, and recommendations.** Zimmermann, R. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Apr 1975. 35p. (In German). Dep. NTIS (US Sales Only) $4.75.

This paper shows some fundamentals of man--machine communication and deduces demands and recommendations for the design of communication systems. The main points are the directives for the design of optical display systems with details for visual perception and resolution, luminance and contrast, as well as discernibility and coding of displayed information. The most important rules and recommendations for acoustic information systems, control devices and for design of consoles are also given. (2 figures, 5 tables) (auth)

3634 (KFK-PDV—45) **Selection of input devices and controls for modern process control consoles.** Hasenfuss, O.; Zimmermann, R. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Jun 1975. 53p. (In German). Dep. NTIS (US Sales Only) $5.75.

In modern process control consoles man--machine communication is realized more and more by computer-driven CRT displays, the most efficient communication system today. This paper describes the most important input devices and controls for such control consoles. A number of facts are given, which should be considered during the selection. The aptitude of the described devices for special tasks is discussed, and recommendations are given for carrying out a selection. (3 figures, 5 tables) (auth)

3635 (LA—5838) **Petrography and chemistry of minerals and glass in rocks partially fused by rock-melting drills.** Ehrenberg, S.N.; Perkins, P.C.; Krupka, M.C. (Los Alamos Scientific Lab.; N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 46p. Dep. NTIS $5.45.

Petrographic examination and microprobe analyses of samples from the walls of glass-lined holes produced by the Subterrene rock-melting drill reveal a gradation in textural, mineralogical, and chemical effects from the penetrator face outward into the unaltered rock. Fusion effects are highly variable in different rock types. In volcanic and sedimentary samples, finer grained matrix material melts most readily, leaving larger residual mineral grains immersed in a highly inhomogeneous, inclusion-rich glass. Spherulitic crystals which are interpreted to have grown during sample quenching are abundant in the fused zones of most specimens. Subterrene samples show analogous textures to rocks which have undergone partial fusion in natural processes (such as xenoliths in lavas and rocks fused by shock metamorphism). Spherulites in the Subterrene glasses resemble spherulites in quenched deep sea basalts, rhyolites, and some lunar rocks. The rapidity of fusion and quenching during Subterrene penetration precludes attainment of chemical equilibrium in the molten zone of Subterrene samples. Textural evidence for nonequilibrium includes quench spherulites, reaction rims on residual crystals, and "fingerprint" textures in partially melted feldspars. (auth)

3636 (LA-UR—75-877) **Thermal analysis of some subterrene penetrators.** Fisher, H.N. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 16p. (CONF-751106—17). Dep. NTIS $4.50.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Various types of rock melting drills have been designed at Los Alamos. These have included density consolidating penetrators up to 90 mm in dia of varying configurations. A number of these consolidators have been tested in loams, alluvium, and tuff. A 114 mm coring penetrator and a consolidator utilizing a heat pipe have also been tested in tuff. Extruders up to 87 mm in dia designed for an improved advance rate have been used in alluvium and basalt. An extruder of 84 mm dia and having an extended surface area has been extensively tested and has produced a thirty metre deep hole in basalt. The results of thermal analyses of some of these existing penetrators under conditions of constant advance rate in tuff, alluvium and basalt are presented. The basic finite element heat conduction code (AYER) used in the calculations is briefly reviewed along with the methods of including radiation, temperature dependent material properties, and power generation. The internal temperature distribution, power requirements and possible advance rates are determined for various consolidating and extruding penetrators. The effects of rock properties, penetrator configuration, and thermal limitations on the advance rate are considered. Heater designs and the use of heat pipes in specific designs are discussed. A comparison with experimental test data is made where possible. Modifications of present designs intended to increase the advance rate and to produce a penetrator capable of drilling to 10 km depths are suggested. (auth)

3637 (ORNL-TM—4777, pp 2-59) **Centrifugal fast analyzer development.** Burtis, C.A.; Bahner, C.T.; Bauer, M.L.; Bostick, W.D.; Johnson, W.F.; Scott, C.D.; Tiffany, T.O.; Overton, J.B.; Lovelace, R.C. Jul 1975.

In Experimental Engineering Section semiannual progress report.

Three miniature analytical systems, each consisting of a miniature Centrifugal Fast Analyzer, several rotors, a sample-reagent loader, a rotor cleaning station, and a computer or a data printer, have been developed and fabricated. These systems are now either being evaluated or routinely operated in the clinical laboratories of the NASA Johnson Space Center, Houston, Texas, the National Institutes of Health, Bethesda, Maryland, and the Health Division of the Oak Ridge National Laboratory. The design and development of rotors, as well as new data systems, have continued to command high priority in the development program. To broaden the range of applications of the analyzer, a multipurpose optical monitor was developed and various alternative light sources were considered. The development of various chemical and hematology procedures was extended to include an enzymatic method for serum cholesterol, the measurement of prothrombin times, and the development of a kinetic protocol to differentiate the A and B variants of glucose-6-phosphate dehydrogenase, an enzyme found in red blood cells. The second prototype of a portable analyzer was evaluated, and several chemical procedures for the analysis of inorganic constituents of water were adapted for use with it. (auth)

3638 (SAND—75-0501) **Numerical analysis of spark drill phenomenology.** Lawrence, R.J.; Young, E.G. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 61p. Dep. NTIS $5.45.

Both one- and two-dimensional numerical techniques have been used to examine the early time shock behavior and the late time bubble dynamics associated with the operation of spark drills. Scaling laws for many significant parameters have been stated and verified, and their relevant consequences have been examined. (auth)

3639 (SAND—75-5502) **Parachute cluster dynamic analysis.** Wolf, D.F.; Spahr, H.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 9p. (CONF-751127—1). Dep. NTIS $4.50.

From 5. AIAA aerodynamic deceleration systems conference; Albuquerque, New Mexico, USA (17 Nov 1975).

A computer-aided dynamic analysis of a parachute cluster is described which models the individual parachutes in the cluster and their combined effects on the motion of the attached forebody. The complex three-dimensional motions of the forebody/parachute system are displayed using computer generated drawings of the bodies. Actual motion studies are accomplished using computer generated color movies. Simulated motion drawings and drop test photographs are presented for a system consisting of a cluster of three small parachutes attached to a large forebody and for a cluster of three large parachutes attached to a small forebody which experiences a rapid pitch motion. The necessity of modeling each parachute individually is illustrated for both systems. (auth)

3640 (UCID—16918) **System to produce low concentrations of gas and solvent vapor in air.** Nelson, G.O.; Taylor, R.D.; Johnson, H.B. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1975. Contract W-7405-Eng-48. 10p. Dep. NTIS $4.50.

A system to continuously produce known concentrations of either gas or solvent vapor in a moving air stream is described. It is a positive displacement device with a dynamic concentration range of approximately 1 to 10,000 ppm at flowrates varying from 1 to 16 l/min. The system is capable of handling any gas which is compatible with glass and Teflon, and any vapor which is compatible with aluminum and stainless steel. (auth)

3641 (UCRL—76125) **Some aspects of micro-drill technology.** Ellers, R.C.; Spies, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1974. 4p. (CONF-741108—6). Dep. NTIS $4.00.

From Society of Manufacturing Engineers conference; San Francisco, California, USA (19 Nov 1974).

Providing research equipment for the many and varied projects at Lawrence Livermore Laboratory leads to interesting machining requirements. One of these is the need to drill very small holes, and in a variety of materials. Holes down to 0.001 in. in dia, approximately 12 dia deep, in brass, steel, stainless steel, copper, gold, plastics, uranium, etc., are not uncommon. This paper discusses methods of sharpening microdrills down to .001 in. in dia and some results obtained with their use. (TFD)

3642 (UCRL—77350) **19 mm ballistic range: a potpourri of techniques and recipes.** Carpluk, G.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 23 Sep 1975. 18p. (CONF-750981—2). Dep. NTIS $4.00.

From 26. meeting of the aeroballistic range association; San Leandro, California, USA (30 Sep 1975).

The expansion of ballistic gun range facilities at LLL has introduced state-of-the-art diagnostic techniques to glovebox-enclosed ballistic guns systems. These enclosed ballistic ranges are designed for the study of one-dimensional shock phenomena in extremely toxic material such as plutonium. The extension of state-of-the-art phtographic and interferometric diagnostic systems to glovebox-enclosed gun systems introduces new design boundaries and performance criteria on optical and mechanical components. A technique for experimentally evaluating design proposals is illustrated, and several specific examples (such as, target alignment, collateral shrapnel damage, and soft recovery) are discussed. (auth)

3643 (UCRL—77352) **Glovebox-contained forty-millimeter gun system for the study of one-dimensional shock waves in toxic materials.** Honodel, C.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Sep 1975. 10p. (CONF-750981—1). Dep. NTIS $4.00.

From 26. meeting of the aeroballistic range association; San Leandro, California, USA (30 Sep 1975).

A new gun system is being constructed at the Lawrence Livermore Laboratory for studies of the behavior of toxic materials under shock-loaded conditions. Due to the extreme toxicity of some materials, such as plutonium, the entire gun system must be enclosed in gloveboxes. Some of the experimental requirements that affected the design of the system, various diagnostic techniques that will be employed with the system, and some details of the final design that is presently under assembly are presented. (auth)

3644 (Y—1997) **Fracture-mechanics analysis of a thirty-inch gas autoclave.** Teompson, W.F. (Oak Ridge Y-12 Plant, Tenn. (USA)). 10 Oct 1975. Contract W-7405-eng-26. 23p. Dep. NTIS $4.00.

Corrosion was found in two areas of a thirty-inch, 103.4-MPa (15,000-psi) gas autoclave. Effects of the corrosion on the fatigue life of the vessel were determined, using a fracture-mechanics approach. (auth)

3645 (Y-DA—6375) **High temperature electrical conductivity apparatus.** Lore, J.D.; Ward, M.E.; Richards, H.L.; Stewart, J.H. Jr. (Oak Ridge Y-12 Plant, Tenn. (USA)). 1975. Contract W-7405-eng-26. 15p. (CONF-751056—1). Dep. NTIS $4.50.

From American Chemical Society southeastern-southwestern regional meeting; Memphis, Tennessee, USA (29 Oct 1975).

The design and application of a high temperature test facility comprising a furnace built in the form of a box wherein one or more walls are removable to facilitate access to interior components comprising the conductance cell are described. The system has been used for measuring the electrical conductivity of slags and molten salts. The bridg circuit for conductance measurements is described. (WHK)

3646 (UCRL-Trans—10729) **Determining the elastic modulus of a rock mass by measuring the deformations produced by concentrated loads in an experimental tunnel.** Goffi, L. Translated from *Energ. Elettr.*; **40**: No. 9, 694-698(1963). 18p. Dep. NTIS $4.50.

Within the sphere of technical problems associated with the design large civil engineering works that involve large areas of rock or earth masses (foundations for dams or large buildings, tunnel excavations, etc.) it is becoming increasingly urgent to find more accurate ways of establishing the parameters that relate to geomechanical characteristics. The problem of determining the elastic modulus of a rock mass by means of in-situ tests is examined. To this end an exact theoretical interpretation of the jack loading test in an experimental tunnel of circular cross-section is presented. The interpretation relies upon experimental determinations on fleximetric specimens taken from the tunnel generatrices under load. Additional considerations are given on the applicability and approximation of the method, with reference to specific examples. (auth)

3647 (K-Trans—77) **Effect of blade aspect ratio on the properties of an axial compressor stage.** Gegin, A.D. Translated from *Prom. Aerod.*; **29**: 35-55(1973). 28p. Dep. NTIS $4.50.

An experimental and theoretical study of the performance of axial compressors with rotor blades having different aspect ratios shows an appreciable increase of the pressure coefficient and a decrease of stage efficiency when the aspect ratios of 1.13 or 0.55 are reached at relative hub diameters of 0.6 and 0.803, respectively, in axial compressor stage designs. The efficiency of blade rings with different blade aspect ratios is estimated. The structure of pressure losses in low aspect ratio blade rings is analyzed and the losses are calculated. A method is proposed for calculation of pressure losses. Design recommendations are given for the enhancement of axial compressor efficiency. (auth)

3648 **High accuracy, high resolution, remote control uniaxial stress apparatus.** Gorman, M.; Doehler, J.; Solin, S.A. (Univ. of Chicago). *Rev. Sci. Instrum.*; **45**: No. 12, 1592-1597(Dec 1974).

A uniaxial stress apparatus designed for low-temperature light-scattering experiments is described. It is more compact and potentially more accurate than previous designs. The apparatus can be used to produce a compressive uniaxial force of up to 8.92 X 10^8 dynes with an estimated accuracy of 1.5 percent and can operate in a temperature range of 1.2 to 300°K. The design does not restrict this apparatus to light-scattering measurements and it could be easily modified for application to tensile uniaxial stress. This apparatus has been used to observe the splitting of the valley-orbit Raman line in Ge(As) as a function of uniaxial stress along the [110] axis and to successfully apply the highest reported uniaxial stress along the [110] axis in germanium, 23 kilobar. (auth)

CRYOGENIC AND SUPERCONDUCTING EQUIPMENT AND DEVICES

3649 (CONF-750845—1) **Low temperature Moessbauer thermometry.** Maletta, H.; Shenoy, G.K. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-48. 5p. Dep. NTIS $4.00.

From International conference on low temperature physics LT 14; Helsinki, Finland (Aug 1975).

In Moessbauer low temperature thermometry the temperature is determined from the relative intensities of the various hyperfine lines as these are affected by the temperature dependent Boltzman populations of the hyperfine levels in the resonant nuclei. One can perform either source experiments or those that make use of the nuclear polarization in the absorber. The second method is more advisable because the radioactive heating is much smaller. The present work is concerned with a fundamental difficulty in absorber thermometry which arises from the fact that the line intensity in a Moessbauer spectrum is also dependent on the absorber thickness, the dependence on that is not a linear one. It is demonstrated that if this thickness effect is not analyzed properly, the experimental results will yield erroneous temperature values, destroying the absolute nature of the Moessbauer thermometer. (WHK)

3650 **Energy and cryoengineering.** Hammel, E.F. (Los Alamos Scientific Lab., NM). pp 11-16 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

Various aspects of the energy problem are described from the standpoint of cryoengineering including energy systems, energy growth, and energy policy. An R and D taxonomy is developed which is then used to organize energy-related cryoengineering technology. Several of these technologies are discussed. (auth)

3651 (NBSIR—75-823) **Helium research in support of superconducting power transmission.** Arp, V.D.; Daney, D.E.; Frederick, N.V.; Jones, M.C.; Ludtke, P.R.; Parrish, W.R.; Powell, R.L. (National Bureau of Standards, Boulder, Colo. (USA). Inst. for Basic Standards). Oct 1975. 80p. Dep. NTIS $4.75.

The first annual report on a program of helium-related research in support of superconducting power transmission is presented. Program areas reported on are concerned with the dynamics of helium cooling systems--theoretical aspects of oscillatory behavior and experiments--and helium related measurements. The latter include pressure measurement, temperature measurement and the problem of impurity levels in the helium refrigerant. (auth)

3652 **Superconducting power transmission programs in the USA.** Belanger, B.C. (Atomic Energy Commission, Washington, DC). pp 51-53 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

In the United States there are currently four laboratory programs specifically devoted to superconducting transmission. Additional supporting research is underway at other laboratories. This review paper describes the organization of these programs and summarizes recent technical accomplishments. (auth)

3653 **Superconducting magnetic energy storage.** Laquer, H.L. (Los Alamos Scientific Lab., NM). pp 71-77 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

After a brief review of the reasons for and forms of secondary energy storage and of the elements and history of inductive or magnetic storage, we discuss the four regions in which superconducting magnetic energy storage can be applied. Differences in energy transfer times place different requirements on the storage coil, on the switch and on the energy losses in the superconductor. We report on designs and experiments in one of these areas with 2 to 300 kJ units, and on the analysis and plans for an installation that is to provide 250 MJ of plasma compression energy for the theta-pinch controlled thermonuclear fusion physics test reactor. We point out those elements of inductive storage that need further development before a theta-pinch fusion reactor can become economically competitive. Finally, we compare the size and costs of the energy storage components of these systems with similar and with larger inductive storage systems that are to interact reversibly with electric utility networks. (auth)

3654 **Conductor tests for dc superconducting power transmission.** Bartlett, R.J.; Hammel, E.F.; Hoffer, J.K.; Keller, W.E.; Kerr, E.C.; McDonald, T.E.; Taylor, R.D.; Trela, W.J. (Los Alamos Scientific Lab., NM). pp 174-176 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

The cryogenic and electrical aspects of a new program to evaluate superconductors suitable for a dc superconducting power transmission line are presented. Short sample tests at 4° at currents up to 39 kA and test-bed operation up to 10 kA are described. (auth)

3655 **Thermometric characteristics of some 1/8W carbon resistors in the millikelvin range.** Radebaugh, R.; Holste, J.C.; Siegwarth, J.D. (National Bureau of Standards, Boulder, CO). pp 253-255 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

Gotoh and Awano have reported on the useful characteristics of $^1/_8$ W 100 Ω Matsushita carbon resistors (grade ERC-18GK) as thermometers for the region 0.4°K and 4.2°K. Measurements on the resistance characteristics of this grade of resistors from 11°mK to 1°K are reported. Nominal resistances of 56 Ω, 68 Ω, 82 Ω, 100 Ω, and 220 Ω were measured. It was found that the 56 Ω, 68 Ω, and 82 Ω resistors make useful thermometers down to at least 11°mK. A comparison of the resistance behavior of units immersed in dilute ^{3}He-^{4}He with those outside the liquid was also made. (auth)

3656 **Short sample test of superconducting wire.** Price, M.E.; Yamada, R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1190-1193(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Two different techniques were used for short sample tests of superconducting wires. One method was done with a dc transformer and the other with a high current dc power supply. Three different types of sample holders were used for the latter, and their relative merits are compared. Many wire designs, representing half a dozen companies, were tested, and their results are presented. For the short sample test, quench current and current at various resistivities were determined. Resistivity ratios of rho/sub 300//RHO/sub 12/ were found for copper, and the effect of cold work on these ratios was investigated. (auth)

PROTECTIVE STRUCTURES AND EQUIPMENT

3657 (CONF-751029—2) **Design requirements and performance requirements for reactor fuel recycle manipulator systems.** Grundmann, J.G. (Oak Ridge National Lab., Tenn. (USA)). 1975. 14p. Dep. NTIS $4.50.

From National bureau of standards workshop; Annapolis, Maryland, USA (23 Oct 1975).

The development of a new generation of remote handling devices for remote production work in support of reactor fuel recycle systems is discussed. These devices require greater mobility, speed and visual capability than remote handling systems used in research activities. An upgraded manipulator system proposed for a High-Temperature Gas-Cooled Reactor fuel refabrication facility is described. Design and performance criteria for the manipulators, cranes, and TV cameras in the proposed system are enumerated. (LCL)

HANDLING EQUIPMENT AND PROCEDURES

3658 (BNWL-SA—5547) **Criticality safety training program at Battelle-Northwest.** Friar, D. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 3p. (CONF-751101—50). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

The criticality safety training program used at Battelle-Northwest is described. In this program criticality safety specialists, dealing with small groups of fissile materials handlers, explain the principles of criticality safety and show how these principles are actually applied in the laboratory. (LCL)

3659 (DP-MS—75-89) **Subcritical mass limits for the T-insert.** Clark, H.K. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 8p. (CONF-751101—43). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Safe limits are derived for Class III shipments of ^{235}U, ^{239}Pu, and ^{233}U in the T-insert within the ANL T-2 cask. The cask has a 6.063-in.-dia cavity enclosed by lead 8 in. thick and clad with steel. The insert is 5-in. Schedule 40 stainless steel. No control is exercised over the configuration of the fissile material. The most restrictive of the conditions that must be satisfied for a Class III shipment is the requirement that the cask be subcritical when flooded internally and externally with water. Mass limits for the cask were calculated by ANISN with S_4 quadrature. Hansen-Roach cross sections were used, supplemented by some with the same group structure from other sources. To establish the bias in the method, calculations of k/sub eff/ were compared with appropriate critical experiments with aqueous solutions of ^{233}U, ^{235}U, and Pu and with HFIR experiments in which the core was reflected by steel, lead, and water. (TFD)

SHIPPING CONTAINERS

3660 (SAND—75-0446) **Final report on special tests on plutonium oxide shipping containers to FAA flight recorder survivability standards.** McWhirter, M.; Brooks, R.O.; Stomp, J.M.; Dillingham, L.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 172p. (NUREG-SAND—75-0446). Dep. NTIS $7.75.

The purpose of the test series was to evaluate the leak tightness of typical plutonium oxide shipping containers when subjected to the same test requirements to which the FAA subjects their flight recorders. The containers chosen for evaluation were the LLD-1 package made by Dow and revised by DuPont, the Rocky Flats Model 1518 (DOT-SPEC 6M) container, and the Nuclear Containers, Inc., Modified FL-10 Container modified to 55-gallon drum size. The tests included impact, penetration, static crush, fire resistance, and water resistance. (TFD)

LASERS

3661 (COO—2521-1) **Lasers for isotope separation. Progress report, 1 January 1975—31 July 1975.** Scully, M.O.; McCarthy, R.J. (Arizona Univ., Tucson (USA). Dept. of Physics). Aug 1975. Contract E(11-1)-2521. 9p. Dep. NTIS $4.00.

Research carried out in four areas related to the general problem of developing lasers for isotope separation is described. The first area of research deals with the general theory of semiconductor lasers. A formalism for semiconductor lasers similar to the Lamb-Scully theory of the gas laser is developed. The second problem considered is the anomalous absorption seen when InSb is irradiated by a high power CO_2 laser beam. This effect is important in determining the output power limits of the InSb Raman spin-flip laser. Third, the possibility of producing stimulated emission using free electron beams was investigated. A number of approaches indicating the possibility of obtaining gain from such devices are developed. Considerable work remains to be done to find ways of increasing the gain characteristics. Finally, theoretical

and experimental work on SF_6 isotope separation via one CO_2 laser has been initiated. (auth)

3662 (LA-UR—75-1422) **Pulsed hydrogen fluoride laser oscillator-amplifier experiments.** Schott, G.L. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 9p. (CONF-750666—1). Dep. NTIS $4.00.

From Seminar on Optical Methods in Energy Conversion; Rochester, New York, USA (23 Jun 1975).

Pulsed HF chemical laser oscillator energies were scaled from millijoules to several kilojoules over the period 1970-1974, reaching approximately 10 J with SF_6 and transverse discharges, and using electron-beam initiation and elemental F_2 above 1000J. This demonstrated scalability to large energy with acceptable electrical efficiency is only one prerequisite for application of this gas laser in fusion; equally important matters are achievement of focusable, approximately 1 ns pulses, couplable to light-element targets, all from an affordable system. Exploratory MOPA experiments are reported which address control of HF laser beam focusability and pulse duration, using SF_6-based experimental oscillator—amplifier sequences and Pockels' cell switching. Simultaneous multiline lasing with 2.6 less than or equal to lambda less than or equal to 3.1 μm and high specific gain and energy density are particularly important factors encountered with HF, where amplifier pumping and lasing occur in a substantially cw temporal relationship, even in less than 100 ns bursts. Time-resolved SF_6—HI oscillator spectra contain 27 simultaneous lines from six vibrational bands. An apertured, SF_6-hydrocarbon pin-discharge oscillator generates approximately 10 mJ of TEM_{00} radiation, which is amplified to approximately 1 J in approximately 150 ns by a TEA amplifier and propagated tens of meters. A three-stage system coupling these elements through an approximately 1 ns electrooptic gate to a greater than 10 J, e-beam energized amplifier is under development. (auth)

3663 (LA-UR—75-2155) **Cold cathode electron guns in the LASL high power short-pulse CO_2 laser program.** Singer, S.; Ladish, J.S.; Nutter, M.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 24p. (CONF-751108—14). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

The design, operation, and performance of the 200 x 35 cm^2 two sided cold cathode electron gun used in the 2.5 kJ laser system and to be used in the 10 kJ laser are described. (MOW)

3664 (LBL—3916) **Feasibility and advantages of off-resonance lasers in chemically reacting systems.** Harris, C.B. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jun 1975. Contract W-7405-ENG-48. 15p. (CONF-750683—1). Dep. NTIS $4.00.

From 27. international meeting of the Societe de Chimie Physique; Paris, France (17 Jun 1975).

The problem of understanding the semiclassical description of the time evolution of an ensemble of two state systems under the influence of a coherent radiation field is of considerable importance. Previous attempts to deal with these problems have dealt with either broad pulses or ultrashort pulses which allow the use of the rate equations or finite phase memory to be incorporated into the description. In neither case, however, has the effect of incoherent feeding and off-resonance effects in a coherently driven two-level system been analyzed. A closed form solution that includes the effects of relaxation and spontaneous emission between the two levels has been obtained for the general case when the ensemble is being incoherently fed from a population reservoir, as would be the case, for example, in a chemical laser. In addition to providing a basis for understanding the modifications which occur for such a system, the mathematical formulation predicts that an important effect may be observed. This effect, which is termed "kinetic coherence," is the production of a long-term coherent component that results directly from the kinetic feeding. The magnitude of the component is related to the rate of creating excited states, relaxation pathways and the off-resonance frequency. It is shown how, in principle, it is possible to utilize these off-resonance effects in any inhomogeneously broadened system to significantly overcome the losses from T_2 relaxation processes and to provide an experimental system capable of controlling the relative ratio of spontaneous and stimulated emission. Finally, the relationships between chemical kinetics, the off-resonance feature and sustained self-regulation in a system exhibiting gain are discussed. (auth)

3665 (SAND—75-0287) **Technique for precise alignment of small diameter lasers.** McCarthy, A.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 8p. Dep. NTIS $4.00.

The technique is applicable in the alignment of any laser, but is especially valuable if the dia of the lasing medium is small, and/or one of the mirrors in the laser cavity is curved. (auth)

3666 (UCID—16931) **Piezo-electric fluid dye cell pump.** McWilliams, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Aug 1972. Contract W-7405-Eng-48. 14p. Dep. NTIS $4.50.

A reliable and compatible pump for a mode-locked oscillator flowing dye cell or other applications utilizing a piezo-electric crystal is described. (auth)

3667 (UCRL—77203) **Physics of relativistic electron beams in rectangular and cylindrical geometries.** Schlitt, L.G.; Bradley, L.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1975. 22p. (CONF-751108—10). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

The use of electron beams for the direct pumping of lasers for fusion applications requires the generation of large area beams in appropriate geometries. Two geometries which are of particular interest are rectangular electron beams with planar anodes and radially converging beams with cyclindrical anodes. The generation of such beams requires the management of electron trajectories in a complex combination of applied and self-generated electric and magnetic fields. The beam's self-electric field limits the emitted current and the deflection of the electron in the self-magnetic field (beam pinch) limits the beam area that can be generated from a single cathode. A simple analytic model is used to derive a scaling relationship for beam pinch in both geometries of the form V/sup 1/2/ w/d = α where V is the diode voltage, w the beam width, d the anode-cathode spacing, and α is a weak function of the geometry. Numerical calculations are presented to show the effects of nonuniform electric fields encountered in typical geometries together with supporting experimental measurements. (auth)

3668 (UCRL—77213) **Electron-beam pumping of visible and ultraviolet gas lasers.** Bradley, L.P. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Sep 1975. 100p. (CONF-750970—1). Dep. NTIS $8.00.

From Proceedings on the physics and technology of high power gas lasers; Capri, Italy (22 Sep 1975).

Several techniques for using direct electron-pumping of gas lasers are reviewed. The primary objective is to categorize pump geometries and to give guidelines for gun selection and pulser design. Examples and application of pump technology are given. (auth)

3669 **Parasitic suppression in large aperture Nd:glass disk laser amplifiers.** Glaze, J.A.; Guch, S.; Trenholme, J.B. (Univ. of California, Livermore). *Appl. Opt.*; **13**: No. 12, 2808-2811(Dec 1974).

Threshold conditions for bulk and surface parasitic oscillations, which may limit energy storage aperture Nd/glass disk lasers, have been developed as a function of material parameters. An expression describing the energy storage distribution within a disk was used to determine the mode that will be most limiting for a particular disk design. Additional modes that may be limiting in special cases were identified and their effects evaluated. These results are useful in developing disk laser designs that minimize parasitic effects. (auth)

3670 **Laser application of heat pipe technology in energy related programs.** Carbone, R.J. (Los Alamos Scientific Lab., NM). pp 1528-1532 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The design of a heat pipe laser is proposed and its application to isotope separation and fusion is discussed. (TFD)

3671 **Generation of a single tunable ultrashort light pulse.** Schmidt, A.J. (Univ. of California, Berkeley). *Opt. Commun.*; **14**: No. 3, 287-289(Jul 1975).

A novel system for generating single tunable ultrashort light pulses of high power is described. The pulse train from a mode-locked flashlamp pumped dye laser passes through an amplifier, which is pumped by an N_2 laser. As gain is only available for a few nsec, only one pulse in the train gets amplified. The energy of the resulting single pulse is about 100 μJ. (auth)

3672 **Prepulse extinction-ratio measurements on a CO_2-laser system.** Manes, K.R.; Smith, D.L.; Haas, R.A.; Glaros, S.S. (Univ. of California, Livermore). *IEEE J. Quant. Electron.*; **QE-11**: No. 8, 635-636(Aug 1975).

Prepulse extinction-ratio measurements performed on two pulse-selection systems at the input and the output of a CO_2- amplifier chain are described. (auth)

HEAT TRANSFER AND FLUID FLOW

3673 (DP-MS—75-15) **Threshold of cavitation in orifices.** Harris, S.D. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 23p. (CONF-751106—9). Dep. NTIS $4.25.

From Annual meeting of ASME; Houston, Texas, USA (30 Nov 1975).

Conditions were determined at which limited cavitation begins (vapor bubbles at edge of orifice) in sharp- and square-edged orifices. Tests were conducted with water at 18 to 80°C and downstream pressures from 34.5 to 550 kPa. Piping diameters were 5, 7, 10, 45.7, and 60 cm, with orifice-to-pipe diameter ratios from 0.18 to 0.75. In all tests except those with 60-cm piping, a window or clear section was provided downstream for visual observation of cavitation. The possibility of reducing the degree of cavitation while maintaining a given pressure loss by various orifice modifications was investigated. Data illustrating cavitation and vibration characteristics of the various orifices are presented. (auth)

3674 (KAPL-M—7399) **Derivation of a low flow slip model.** Maneri, C.C. (Knolls Atomic Power Lab., Schenectady, N.Y. (USA)). 23 Oct 1967. 17p. Dep. NTIS $4.50.

An expression for slip ratio is derived by coupling the Zuber-Findlay void model with the Wallis flooding criterion. The behavior of the slip ratio for various limiting cases is investigated and it is shown that it approaches realistic limits. (auth)

3675 (NU—2512-4) **Liquid—liquid surface impaction. Progress report, July 1, 1975—September 30, 1975.** Bankoff, S.G. (Northwestern Univ., Evanston, Ill. (USA). Technological Inst.). 1975. Contract AT(11-1)-2512. 20p. Dep. NTIS $4.50.

When a cold volatile liquid droplet approaches the surface of a hot liquid pool, coalescence or rebound may occur. Coalescence may be followed by explosive boiling. Previous experiments have verified that the probability of coalescence depends on the Weber number, the temperature difference between the cold and the hot liquids, the drop diameter, and the nature of the two liquids. In this work the slow viscous flow equations for the air film, coupled with the momentum balance for the droplet, are used to derive an ordinary differential equation for the film thickness as a function of time in a three-phase, unsteady non-isothermal system. It is shown that the Stefan-Reynolds equation and the equations for steady Leidenfrost boiling of a droplet are special cases of the present analysis. An empirical relationship between the minimum thickness of the air film and the system parameters was found, using experimental results for Freon and pentane impacting on silicone oil. (auth)

3676 (ORNL-TM—4759) **Model to calculate mass flow rate and other quantities of two-phase flow in a pipe with a densitometer, a drag disk, and a turbine meter.** Aya, I. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 57p. Dep. NTIS $5.45.

The proposed model was developed at ORNL to calculate mass flow rate and other quantities of two-phase flow in a pipe when the flow is dispersed with slip between the phases. The calculational model is based on assumptions concerning the characteristics of a turbine meter and a drag disk. The model should be validated with experimental data before being used in blowdown analysis. In order to compare dispersed flow and homogeneous flow, the ratio of readings from each flow regime for each device discussed is calculated for a given mass flow rate and steam quality. The sensitivity analysis shows that the calculated flow rate of a steam-water mixture (based on the measurements of a drag disk and a gamma densitometer in which the flow is assumed to be homogeneous even if there is some slip between phases) is very close to the real flow rate in the case of dispersed flow at a low quality. As the steam quality increases at a constant slip ratio, all models are prone to overestimate. At 20 percent quality the overestimates reach 8 percent in the proposed model, 15 percent in Rouhani's model, 38 percent in homogeneous model, and 75 percent in Popper's model. (auth)

3677 (SAND—75-0416) **Motion of a loosely fitting piston in a closed end cylinder containing a perfect gas.** Stone, G.W.; Reis, G.E.; Kaestner, P.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 45p. Dep. NTIS $5.00.

The equations of motion are derived for a piston in a closed end cylinder containing a compressible perfect gas. These equations include the possibility of an arbitrary motion imposed on the cylinder. In the analysis, it is assumed that there is a clearance between the piston and the cylinder which is sufficiently small so that the flow in the gap is controlled by viscous forces. Computer code OOPS was written which solves the derived equations of motion. Several cases are examined using the OOPS code. (auth)

3678 (UCRL—51877) **Vapor-droplet flow equations.** Crowe, C.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Aug 1975. Contract W-7405-Eng-48. 31p. Dep. NTIS $4.00.

General features of a vapor-droplet flow are discussed and the equations expressing the conservation of mass, momentum, and energy for the vapor, liquid, and mixture using the control volume approach are derived. The phenomenological laws describing the exchange of mass, momentum, and energy between phases are also reviewed. The results have application to development of water-dominated geothermal resources. (auth)

3679 (ORNL-tr—4026) **Film condensation on surface with fine corrugations, with consideration of surface tension.** Gregorig, R. Translated by M. Gerrard from *Z. Angew. Math. Phys.*; **5**: 36-49(1954). 13p. Dep. NTIS $4.00.

Following a synopsis on film- and drop-condensation, condensation on an uneven surface is discussed. The surface tension gives rise to large pressure gradients because of the different curvatures of the surface of the condensate. The action of the latter can amount to a multiple (up to a few powers with basis ten) of the value corresponding to the gravitation. Large gradients of pressure produce thin films of condensate, and according to the theory of Nusselt they lead to large coefficients of heat transmission. Heat transfer coefficients were determined with calculus of finite differences for a condenser with vertical tubes, grooves parallel to the tube axis, and a given geometrical form. The latter was confirmed by tests. A dimensional number determines the Nusselt number. (auth)

3680 (BNWL-tr—156) **Heat transfer to finned tubes and computation of tube bank heat exchangers.** Schmidt, T.E. Translated from *Kaeltetechnik;* **15**: No. 4, 98-102(1963). 18p. Dep. NTIS $4.50.

For the evaluation of the heat transfer to finned tubes it is advisable to use simple mathematical equations. The computation of the fin efficiency also appears to be useful if the heat transfer coefficient for the fin surface is not a constant. The most important dimensionless group is that one related to the increase of the tube surface through the fins. By using diameters related to the total area of the finned tube it is shown that there exist simple dimensionless equations within the range of practical interest. For tube bundles the number of rows and the degree of the upstream turbulence are of considerable influence. (auth)

3681 (UCRL-Trans—10949) **Minimum specific wetting of flat surfaces.** Hobler, T.; Czajka, J. Translated from *Chem. Stosow., Ser. B;* **5**: No. 2B, 169-186(1966). 32p. Dep. NTIS $5.00.

Experimentally determined minimum specific wetting rates of plane surfaces made of various materials are presented. The wetting was increased starting from zero with an initially completely dry surface. The results are described by a correlating equation which contains the Reynolds number, the equivalent Weber number, and the angle of contact. (auth)

3682 (UCRL-Trans—10730) **Formulation of the boundary conditions for viscoelastic-fluid flows with injection and suction at the walls.** Giesekus, H. Translated from *Rheol. Acta;* **9**: 474-487(1970). 34p. Dep. NTIS $5.00.

The problem of flow of an Oldroyd fluid B between two parallel plates, both moving steadily in their own planes, is analysed. Additionally it is assumed that the fluid is injected with uniform and constant velocity at one plate and is sucked at the other. In order to formulate the boundary conditions in an appropriate manner the problem is idealized in such a way that the whole space is taken to be filled with fluid and instead of porous plates there are two singular planes with uniformly distributed forces. For these planes matching and jump conditions are stated and the existence of asymptotic velocities on both sides are postulated. But, in general, these conditions are not sufficient for the solution of the problem and a further condition, namely that of "back-shielding" at the plate with injection, has to be introduced. The solutions of the above defined problem are given in dimensionless form and discussed in detail. Emphasis is laid on the special case with vanishing retardation (Maxwell-Oldroyd fluid B) because the boundary conditions result here in jumps in velocity, and when a critical value of suction velocity ("velocity of sound"), is attained the flow field changes its character unsteadily in a remarkable manner. Further it is elucidated that the problem in general cannot be solved by the method of "approximation for

slow flows" (Rivlin-Ericksen fluid) but only in that particular case in which the injectional area is taken to be at infinity. For this case solutions for second-order approximation have been given and are compared with the exact solutions. Finally, in two appendices, the expressions for the velocity of propagation of transversal sound waves and for the slope of deformation in the so-called creep and creep-recovery experiment respectively, which are used in the above investigation, are derived in short. (auth)

MATERIALS TESTING

3683 (CONF-750947—, pp 51-81) **Beam-induced temperature changes in HVEM irradiations.** Garner, F.A.; Thomas, L.E.; Gelles, D.S. Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

The peak value of the temperature distribution induced by energy loss of 1.0 MeV electrons in traversing a typical HVEM irradiation specimen can be very substantial. The origin and various features of this distribution were analyzed for a variety of specimen geometries. The major parametric dependencies are shown to be relatively independent of specimen geometry, however, and allow the definition of a scaling relationship that can be employed to predict temperature rises in materials that cannot be measured directly. The use of this scaling relationship requires that the experimenter minimize perturbations of the heat flow due to proximity of the central hole in the specimen. An experimental method of determining directly the magnitude and distribution of beam-induced temperature profiles was developed which utilizes the order-disorder transformation in Fe_3Al and Cu_3Au. Scaling of experimentally determined temperature changes leads to more realistic estimates of the total temperature rise than are currently available in various literature tabulations. The factors which determine the optimum selection of irradiation parameters for a given experiment are also discussed. (auth)

3684 (UCRL—77388) **High voltage photography applied to nondestructive testing.** Lord, D.E.; Petrini, R.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Oct 1975. 19p. Dep. NTIS $4.00.

The application of high voltage photography to a variety of uses in the materials field is described. The technique appears to magnify the surface/sub-surface condition of a material which often is an indicator of the internal state. It appears to be sensitive to impurities and porosities as well. Materials testing and nondestructive testing applications look promising. (auth)

3685 (ORNL-tr—2919) **Stress under service conditions and estimated fatigue life of blades in an axial flow compressor.** Nakamura, H.; Umakoshi, R.; Horikawa, T.; Okazaki, S. Translated by Hisashi Kubota from *Zairyo;* **24**: No. 256, 9-14(1975). 12p. Dep. NTIS $4.00.

In order to evaluate the fatigue strength of blades of an axial flow compressor, the following investigations were performed: strain measurements in service condition; fatigue tests on blade materials under several conditions (under varying stress amplitude and superimposed stress, in corrosion, etc.); and fatigue life prediction. The results of strain measurement of 1st and 14th stages of the rotor blades and prediction of life are explained. Also the problems in evaluating the fatigue strength of the blades are treated. The main results were as follows: stress-frequency curves depend very much on the cycle counting method and the rate of resonance of blade; fatigue life is determined by low level stress having many number of cycles rather than the maximum stress level; and the S-N curve estimated can be used to evaluate the service life of blades. (tr-auth)

3686 (ORNL-tr—4015) **Reliability analysis of fatigue lives of machines and structures under service loads (III).** Ishikawa, H. Translated by H. Kubota from *Zairyo;* **24**: 563-573(Jun 1975). 20p. Dep. NTIS $4.00.

The fatigue strength and fatigue life of machines and structural materials do not assume singular values but are of a rather indeterminate nature. Consequently, it becomes necessary to determine the type of probability distributions these values will follow. If the generation mechanism for fatigue fracture such as the so-called defect physics can be clarified, it should be possible to follow the probability distributions of fatigue strength and life by a theoretical approach. However, this field is presently beset with considerable difficulties. As a result, it becomes necessary to first rely on experience to draw up a fracture probability model that would accommodate data collected in the past and estimate the statistical parameters for the system. The representation of the fatigue life distribution by assuming a Weibull distribution model is but one of the empirical methods presently employed. A method of estimating the statistical parameters (shape parameter or scale parameter) that will characterize the distribution of field data is described. This method assumed that the fatigue life distribution conforms to a 2 parameter Weibull distribution and is compared with a statistical estimation method which uses the parameters derived by such an approach to obtain fatigue lives with the degree of reliability required for the given situation. This type of reliability analysis is discussed and a few analytical examples are described. (auth)

3687 **Interactive/graphics general-purpose NDE laboratory tool.** Stiefeld, B. (Sandia Labs., Albuquerque, NM). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **63**: No. 10, 1431-1437(Oct 1975).

A minicomputer-based laboratory test system at Sandia Laboratories, which acts interactively to control experiments and to apply graphic display techniques to the acquired data, is described. A short description of the hardware is included to emphasize its flexibility and general application in the nondestructive evaluation laboratory. The greater part of the paper covers examples of acquisition and data analysis using the interactive features of the system. (auth)

SAFETY ENGINEERING

3688 (AED-CONF—75-159-000, pp 13-21) **Safety as a factor for the classification of automation systems.** Frey, H. 1975. (In German).

From Conference on technical reliability; Nuernberg, F.R. Germany (26 May 1975).

In Conference 1975: technical reliability.

In order to explain the concept of the qualitative and quantitative evaluation of the reliability and safety of the system, the elements of an automation system regarding reliability analysis are discussed. A general mathematical safety model is developed and discussed by the example of an automatic street signaling system. (auth)

3689 (AED-CONF—75-159-000, pp 83-92) **Mean frequency of system failures and their calculation.** Hoefle-Isphording, U. 1975. (In German).

From Conference on technical reliability; Nuernberg, F.R. Germany (26 May 1975).

In Conference 1975: technical reliability.

The lecture deals with methods to calculate the average number of failures of repairable systems. In the first place, two theorems are given which relate the failure frequency and other reliability parameters to the content. They are generalizations of the theorems from the renewal theory. The statements are then applied to 3 models. From this, various rules are obtained to calculate the average failure frequencies. The first model concerns systems whose function possibilities can be represented by a boolean "system function," the second deals with systems which can be calculated according to the Markow process method, and the third is a generalization of the first. (auth)

3690 (AED-CONF—75-159-000, pp 93-98) **Failure analysis as a means for the improvement of system function reliability.** Niebler, H. 1975. (In German).

From Conference on technical reliability; Nuernberg, F.R. Germany (26 May 1975).

In Conference 1975: technical reliability.

The failure analysis system applied by the BBC with series products and single products is described. For each of these products, a systematic data acquisition is guaranteed with the help of coded failed element catalogues and schematized reported failures. With large units the frequency distribution of the kind of failures and failure sites in the agreed guarantee time is shown. Thus the effectiveness of the product control is assessed. Furthermore, indications for improvements with new constructions are given. (auth)

3691 (AED-CONF—75-159-000, pp 127-132) **Simulation techniques for determining reliability and availability of technical systems.** Lindauer, E. 1975. (In German).

From Conference on technical reliability; Nuernberg, F.R. Germany (26 May 1975).

In Conference 1975: technical reliability.

The system is described in the form of a fault tree with components representing part functions of the system and connections which reproduce the logical structure of the system. Both have the states intact or failed, they are defined here as in the program FESIVAR of the IRS. For the simulation of components corresponding to the given probabilities, pseudo-random numbers are applied; these are numbers whose sequence is determined by the

producing algorithm, but which for the given purpose sufficiently exhibit the behaviour of randomly successive numbers. This method of simulation is compared with deterministic methods. (GE)

3692 (CONF-750607—32) **New method for abbreviating the fault tree graphical representation.** Stewart, M.E.; Fussell, J.B.; Crump, R.J. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA)). Dec 1974. 4p. Dep. NTIS $4.50.

From American Nuclear Society meeting; New Orleans, Louisiana, USA (8 Jun 1975).

Fault tree analysis is being widely used for reliability and safety analysis of systems encountered in the nuclear industry and elsewhere. A disadvantage of the fault tree method is the voluminous fault tree graphical representation that conventionally results from analysis of a complex system. Previous methods for shortening the fault tree graphical representation include (1) transfers within the fault tree, and (2) the use of the SAMPLE (K out of N logic) gate, the MATRIX gate, and the SUMMATION gate. The purpose of this presentation is to introduce TABULATION gates as a method to abbreviate the fault tree graphical representation. These new gates reduce the cost of analysis and generally increase the system behavior visibility that is inherent in the fault tree technique. (auth)

3693 (SAND—75-0360) **Dummy Missile Project.** Stinnett, L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 63p. Dep. NTIS $5.45.

A rocket propelled passenger car carrying two anthropomorphic dummies was impacted into a concrete abutment at 52 mph. Data presented indicates that human passengers would have been killed in the impact. Damage to the car and the dummies is detailed sufficiently to allow readers to use the information for their own purposes. (auth)

ELECTRONIC CIRCUITS AND DEVICES

3694 (AECL—5228) **Development of engineering Application Packages for interactive design of electronic systems.** Shah, R.R.; Yan, G. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Jul 1975. 9p. (CONF-750577—1). Dep. NTIS (US Sales Only) $4.50. AECL $0.50.

From 4.man-computer communications conference; Ottawa, Canada (26 May 1975).

Application Packages provide an efficient and convenient means of using the Advanced Design System (ADS), a computer-based graphic system, in various design activities like hybrid microelectronic circuit layout, printed circuit board layout, cabinet and front panel layout, etc., which are associated with electronic systems engineering. Each Package is tailored to a specific design activity, thereby considerably simplifying its use. Moreover, the Packages are sufficiently similar that a user familiar with one can learn to apply any other rapidly. This paper describes the concepts and technical details of Application Packages, and the scheme use for their development is presented. Examples of presently available Packages are also given. (auth)

3695 (AED-CONF—75-159-000, pp 23-31) **Safety of parallel-redundant circuits. A systems comparison.** Schneider, W. 1975. (In German).

From Conference on technical reliability; Nuernberg, F.R. Germany (26 May 1975).

In Conference 1975: technical reliability.

The influences on the safety of electronic circuits are particularly investigated which are to be traced back to component failures. An attempt is made to realize "failsafe" requirements, which guarantee an absolute safety, by repairable, adaptive (n-1)vn systems. (GE)

3696 (BDX—613-1244(Rev.)) **Thread certification. Final report.** Berry, C.W. Jr. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 51p. Dep. NTIS $5.45.

Air gaging of blind and through-type miniature threaded holes has proven feasible. Efforts to determine the flow at minimum and maximum threaded hole geometries were not successful. Additional work to determine these limits has been recommended. As a result of this work, a technique for air gaging hole diameters in printed circuit boards has been developed. This technique is recommended to replace plug gaging of these holes which is now considered a destructive test. (auth)

3697 (BDX—613-1285) **Capping fixture for discrete semiconductors.** Coupland, W.C. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 21p. Dep. NTIS $4.00.

The installation of caps on discrete semiconductors before the cap welding operation is a critical process. Any contact of the cap with the internal structure of the device can result in damage that will reduce yields and create latent reliability hazards. A prototype capping fixture, designed to eliminate the possibility of damage during cap installation, was generated. Considerable difficulty, due to maintenance of close tolerances, was met while fabricating this fixture. Complete success was not achieved within the expenditure level of this PDO budget allocation; however, the concept of the capping fixture was shown to be feasible, and a basis was laid for future work in this area. (auth)

3698 (BDX—613-1286) **Phototool fabrication methods. Final report.** Wilson, M.L. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 33p. Dep. NTIS $4.00.

New photographic materials and fabrication techniques have been implemented in the production of phototools used for the manufacture of printed circuits. A bombsight punch was designed and built for accurately locating and punching tooling holes in the film. Phototool tolerance capabilities have been improved with a reduction in fabrication time and cost. (auth)

3699 (BDX—613-1424(Rev.)) **Glass sealing process for electrical feedthroughs.** Gates, W.G. (Bendix Corp., Kansas City, Mo. (USA)). Oct 1975. Contract AT(29-1)-613. 20p. Dep. NTIS $4.00.

This process development was undertaken to develop glass-to-metal sealed electrical feedthroughs. This knowledge is necessary to provide the engineering support required to obtain quality vendor supplied glass-to-metal sealed components. An extensive literature search revealed that cleaning, oxidizing, sealing, and plating were necessary for making glass-to-metal sealed assemblies. These procedures were applied to the XL0001 and XL0003A so that assembled headers could be sealed and evaluated in the laboratory to determine the problems related to processing glass-to-metal sealed electrical feedthroughs. This information was used to pinpoint problem areas in glass-to-metal sealing and to establish the feasibility of developing a backup sealing capability. Successful glass-sealed feedthroughs have been made that were crack free, leak tight, and dimensionally acceptable. Several tests were run to optimize the cleaning, oxidizing, sealing and plating process on laboratory equipment. Seventeen XL0001 and twenty-three XL0003A header assemblies were built with these schedules. All assemblies inspected met the drawing requirements. This process development established that glass-to-metal seals can be made using published procedures and proved that a backup production capability is feasible. However, due to the limited scope of this short term process development endeavor, several technical aspects were not investigated. These areas include: minimization of stress in glass, measurement of stress in glass, effects of cleaning procedures on porosity, relation to oxide thickbess to sealing profile, and development of insepction techniques for glass-to-metal seals. (auth)

3700 (BDX—613-1464) **Automatic lead frame plating. Final report.** Jarboe, D.M. (Bendix Corp., Kansas City, Mo. (USA)). Nov 1975. Contract AT(29-1)-613. 38p. Dep. NTIS $4.00.

An automated plating system has been developed which will enable microelectronic lead frames to be gold plated with improved quality and at significantly lower cost. Based on the concept of continuous plating, this system eliminates the need for manual fixturing of short lengths by providing a method of processing lead frame material in a continuous strip form. The feasibility of continuously monitoring the gold thickness on a copper lead frame was established using a specially developed scintillation type beta backscatter probe. This measurement system as it currently exists, is capable of a precision of 5 percent. (auth)

3701 (LBL—3592) **Amplitude fluctuations of Johnson noise in semiconductors and discontinuous metal films: 1/f noise in an equilirium system.** Voss, R.F.; Clarke, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-Eng-48. 5p. (CONF-750937—2). Dep. NTIS $4.00.

From 4. international conference on physical aspects of noise in solid state devices; Noordwijerhout, Netherlands (9 Sep 1975).

Thermal noise measurements on semiconductors and metals indicate that first, 1/f noise does not require a long-term steady current, and second, that the fluctuations in the mean-square Johnson noise voltage have a 1/f spectrum that arises from resistance fluctuations. (TFD)

3702 (SAND—74-0448) **2000 watt-GHz TRAPATT oscillator. Final report.** Liu, S.G. (RCA Labs., Princeton, N.J. (USA)). Nov 1974. Contract 11-6604. 82p. Dep. NTIS $7.25.

For Sandia Lab., Albuquerque, NM.

The investigation of TRAPATT diodes during the program period has met the goals of the contract. Series-stacked TRAPATT diodes with greatly improved device and packaging technology

have been developed. Kilowatt power output has been obtained at 2 GHz with 0.5 percent duty cycle from a three-diode stacked unit in a compact microstrip circuit. The same power level has been reached at 1.5 GHz from a two-diode stack. The efficiencies at the kilowatt power level are 27 percent and 29 percent at 2 GHz and 1.5 GHz, respectively. Substantial progress has been made in the area of circuit technology. A semilumped-element circuit has been developed which consists of two Johanson capacitors incorporated in a short length of microstrip line. A double-ended TRAPATT diode structure has been developed. The device has the advantage of increased impedance level and increased power output without the complexity of multipole diode geometry. Power output of 300 W at 2 GHz with 27 percent efficiency has been obtained from single diodes on a microstrip circuit. The broad bandwidth and long-pulse operation capabilities make the device attractive for phased array radar applications. In the study of BARITT devices, both p-type and n-type structures have been fabricated. (TFD)

3703 (SAND—75-0281) **Correlation between bond reliability and solid phase bonding techniques for contaminated bonding surfaces.** Bushmire, D.W.; Holloway, P.H. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 24p. Dep. NTIS $4.50.

The relationship between bond reliability and the solid phase bonding technique used to interconnect on contaminated substrates has been investigated. Hybrid microcircuit substrates were contaminated with Shipley 1350H photoresist. Solid phase bonds on these HMC substrates were made using six different techniques. The reliability of the bond was determined by destructive testing, recording both the failure strength and failure mode. A bond lift or delamination is indicative of poor reliability in bonds. The order or decreasing sensitivity to contamination (no bond delaminations with increasingly higher contamination levels) for the six different bonding techniques is compliant beam lead, thermocompression fine gold wire, wobble beam lead, thermosonic fine gold wire, thermocompression lead frame, and ultrasonic fine wire aluminum. No degradation of thermocompression fine gold wire or ultrasonic fine wire aluminum bonds on contaminated substrates was observed on accelerated aging treatment of 100°C in air for up to 1000 h. (auth)

3704 (SAND—75-0434) **Micro-size plated through connections in flexible cables.** Voida, G. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 71p. Dep. NTIS $5.50.

A production process for the electroless/electrolytic plating of copper plated-through holes (PTH) in flexcircuits is described. Plated holes as small as 0.013 inch in diameter were produced in two-mil thick Kapton insulation. Six by ten test panels containing six straight conductors with 20 PTH's per conductor were evaluated. Results in the present study confirm that flex circuits with microsize PTH's can be very reliable for use in complex electronic assemblies and in weapon applications. (TFD)

3705 (SAND—75-0467) **Monte-Carlo analysis of a radar-fuze digital integrator.** Williams, C.S.; James, L.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Oct 1975. Contract AT(29-1)-789. 28p. Dep. NTIS $4.00.

The memory time of an RC integrator (i.e., a single-pole, low-pass filter) is proportional to the product of the resistance R and the capacitance C. Thus, the memory time will tend to vary with environment and from unit to unit in production. In a radar fuze, the RC-integrator variation influences the premature probability and must be accounted for in the design. This report compares a digital integrator (which can be made less subject to environmental and production variations) consisting of an up-down counter, with periodic division by two of the resultant count to make the memory time finite, with an RC integrator in a pulse-radar application. The digital integrator is required to provide the same premature probability as the RC integrator (neglecting environmental and production variation). The comparison shows that the digital integrator requires about one dB more signal power at the radar-receiver input than the RC integrator to provide the same probability of firing when the fuze reaches burst height. If the RC integrator variations were taken into account, it is likely that it would require more signal power than the digital integrator. (auth)

3706 (SAND—75-0475) **WIPE: reverse wipe design and the evaluation of brass—copper—beryllium for electrical contacts under highly contaminating conditions.** Cuthrell, R.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 13p. Dep. NTIS $4.00.

A wipe-reverse wipe technique, which may be incorporated in the design of electrical contact closure mechanisms, was found to markedly decrease the contact resistance of electrical switches even when very heavily contaminated with surfaces oxides, sulfides, or chlorides. The use of this technique reduces the sensitivity of electrical contact operation to environmental contaminants, allows a reduction in the closure force, and allows the substitution of inexpensive base metals for precious metals in many electrical contact applications. Brass and copper-beryllium contacts were elevated under several very highly contaminated conditions. (auth)

3707 (SAND—75-5425) **Local fields at the cathode-insulator junction as a cause of breakdown of shaped insulators in vacuum.** Brainard, J.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 11p. (CONF-751112—2). Dep. NTIS $4.00.

From Annual conference on electrical insulation and dielectric phenomena; Gaithersburg, Maryland, USA (3 Nov 1975).

High-voltage holdoff of solid insulators between electrodes in vacuum depends strongly on insulator shape. The angle between the applied field and the insulator interface is believed to be the fundamental dependence. A detailed calculation of the electric fields about solid insulators of various shapes is presented which gives an insight into the reason for this dependence. The breakdown field near the cathode-insulator junction appears to be constant if the enhancement of the a2alied field is considered. This enhancement is created not only by insulator geometry, but also by insulator surface charging effects. (TFD)

3708 (SAND—75-5455) **Time-resolved measurements of surface flashover of conical insulators.** Anderson, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 13p. (CONF-751112—1). Dep. NTIS $4.00.

From Annual conference on electrical insulation and dielectric phenomena; Gaithersburg, Maryland, USA (3 Nov 1975).

The voltage at which an insulator in vacuum flashes over depends on the angle between the insulator-vacuum interface and the electric field. Test samples of Plexiglas (PMMA) in the form of truncated cones 0.6 cm thick were subjected to high-voltage pulses in vacuum (10^{-5} to 10^{-6} torr pressure). The conical surfaces of the samples were of uniform roughness, achieved by circumferential polishing with 400 grit silicon carbide paper. The samples were cemented to stainless steel electrodes of larger diameter without visible gaps at the insulator-electrode junctions. Flat-topped, high-volte pulses with 3 ns risetime were generated by collecting a pulsed electron beam on the cathode electrode of the sample, where the charge was stored prior to breakdown. The applied voltage and time delay prior to breakdown were obtained from waveforms recorded with the aid of a capacitive voltage divider. The time resolution was better than a nanosecond. As a result, true flashover breakdowns were easily distinguished from leakage currents, sometimes as large as several kA, which often occur for insulators having positive cone angles (base of the frustum at the cathode electrode). Such currents appeared to be emission across the vacuum gap from the insulator-cathode junction. Surface flashovers on the PMMA samples were characterized by an abrupt collapse of insulator impedance, typically falling through greater than 10^3 Ω to a fraction of an ohm within a nanosecond. This collapse launches an underdamped oscillatory current in the breakdown channel. The delay prior to breakdown was measured from the point in time the high-voltage pulse attains 90 percent of its maximum value. (TFD)

3709 (SAND—75-6092) **Fabrication of 2-4 mum magnetic bubble memeories with electron beam negative resist lithography.** Sweet, J.N.; Schroeder, D.H.; Maurin, J.K.; Adams, J.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 10p. (CONF-751209—2). Dep. NTIS $4.50.

From 21. annual conference on magnetism and magnetic materials; Philadelphia, Pennsylvania, USA (9 Dec 1975).

Electron lithographic techniques with co-polymer (Co-P) negative resist and ion milling were used to fabricate small prototype 2μm and 4 μm, single level bubble test circuits. The 4 μm circuits were used to evaluate two different generator and two different detector designs while the 2 μm circuits were used to study small bubble propagation characteristics. The minimum interelement spacing which could be routinely produced was about 0.8 μm which is just adequate for reliable 2 μm bubble propagation. (auth)

3710 (SAND—75-8053) **Multi-use adjustable lead-forming tool.** DuBose, D.T. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 20p. Dep. NTIS $4.50.

A lead-forming tool that will accommodate a wide range of sizes and styles of flat packs has been designed. Its adjustable features include positioning of the die sets, punches, and tool base. Because it adapts to a large spectrum of commercially produced sizes and shapes, it greatly reduces the amount of tooling needed. (auth)

3711 (UCRL—77448) **Procedure for cleanup of computer routed printed circuit boards.** Castleton, R.N. (California Univ.,

Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. 8p. (CONF-751109—4). Dep. NTIS $4.50.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

The Design Automation Group at Lawrence Livermore Laboratory developed a router-independent cleanup procedure to correct some of the problems found in computer generated layouts of printed circuit boards. The types of problems encountered and the solution techniques used in the cleanup procedure are described. The important points of the cleanup algorithm are described, and an example of a PC board route with and without use of the cleanup package as an intermediate step is presented. (4 figures, 1 table) (auth)

3712 (UCRL-Trans—10924) **Study of a high-speed foil circuit-breaker. 1. Electrical explosion of foils in pulverized quartz.** Andrezen, A.B.; Burtsev, V.A.; Vodovozov, V.M.; Dubovoi, L.V.; Produvnov, A.B. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). 1975. Translation of NIIEFA-K—0226. 18p. Dep. NTIS $4.50.

Experimental results obtained in the study of the electrical explosion of aluminium foils in pulverized synthetic quartz with a grain size of approximately 1 μ are described. (auth)

3713 **Isolating dc—dc coupler.** Dandl, R.A.; Wintenberg, R.E. (Oak Ridge National Lab., TN). *Rev. Sci. Instrum.;* **46**: No. 6, 784-785(Jun 1975).

A simple circuit is described which accurately couples a dc signal across a dc potential of several hundred volts. The method of extending the current linearity of the high-voltage transistor used to perform this function is probably useful in other applications. (auth)

3714 **Threshold switching in melanin.** Culp, C.H.; Eckels, D.E.; Sidles, P.H. (Ames Lab., IA). *J. Appl. Phys.;* **46**: No. 8, 3658-3660(Aug 1975).

Threshold-switching measurements of synthetic melanin confirm that this organic semiconductor switches to a low-resistance state in low electric fields as reported by McGinness et al. Time-dependent current-vs-voltage curves show that the time to traverse the negative-differential-resistance (NDR) segment is much slower than would be expected from electronic-switching mechanisms. Double-pulse measurements add to the evidence that thermal effects dominate electronic effects in melanin. A pseudomemory effect was found in melanin. (auth)

3715 **New type of digital frequency multiplier.** Horelick, D.; Bertolucci, B. (Stanford Univ., CA). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **63**: No. 9, 1365-1366(Sep 1975).

A new technique for frequency multiplication using digital methods is described. The method is primarily useful for low-frequency multiplication and generates equally spaced pulses, although there is a small error due to truncation. (auth)

3716 **Determination of peak distortion for filtered mass spectrometer data.** Brubaker, T.A.; Pomernacki, C.L.; Brackett, H.B. Jr. (Univ. of California, Livermore). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **63**: No. 10, 1467-1475(Oct 1975).

The design procedure along with design curves for specifying the design of analog and digital filters for mass spectrometer data is presented. In developing the procedure, careful attention is given to noise models so that the two filter classes can be compared. The use and benefits of interactive graphics and computer-aided design software for implementing the design procedures are discussed. (auth)

3717 **Linear digital filtering for laboratory automation.** Brubaker, T.A.; Cornett, F.N.; Pomernacki, C.L. (Univ. of California, Livermore). *Proc. IEEE (Inst. Electr. Electron. Eng.);* **63**: No. 10, 1475-1486(Oct 1975).

The design of nonrecursive and recursive digital filters using linear least squares or linear minimum variance is described. This method of design requires a model, and since polynomial approximations are widely used in laboratory automation, a polynomial state model is first utilized. Then an exact scalar signal model is employed that results in a completely time-varying filter. For both models, the design leads to the recursive Kalman filter. The operation of the filters for noise reduction is first demonstrated for simulated data, and design forms are compared. For the exact scalar signal model, noise reduction and peak separation are demonstrated using simulated data and data obtained from a mass spectrometer. By using the correct model, excellent peak separation and noise reduction can be obtained. (auth)

SOLID WASTE PROCESSING PLANTS AND EQUIPMENT

3718 **Energy generation systems adaptable for burning dust-type fuels.** Turner, L.C.; Cockreham, H. (to Turco Engineering, Inc.). US Patent 3,902,436. 2 Sep 1975. Filed date 17 Jun 1974. 12p.

An energy generation system, especially applicable to firetube boilers but also applicable to other combustion-type energy generators, for burning dust-type fuels such as wood sander-dust is described. The system comprises fuel metering apparatus, responsive to system demands, for accurately controlling the fuel-air ratio and modulating the mass flow rate of the dust-type fuel into the combustion chamber. (Official Gazette)

PARTICLE ACCELERATORS

DESIGN, DEVELOPMENT, AND OPERATION

3719 (ANL/SSS—74-1) **Feasibility studies of an accelerator for the intense pulsed neutron source (IPNS).** Khoe, T.K.; Kimura, M. (Argonne National Lab., Ill. (USA)). Nov 1974. Contract W-31-109-Eng-38. 29p. Dep. NTIS $4.50.

A proton linac plus synchrotron system was studied for the proposed Intense Pulsed Neutron Source (IPNS) at Argonne. An Alvarez H^- linac of 70 MeV and a high intensity fast cycling proton synchrotron to accelerate protons to 800 MeV will be the best choice to give a flux of 10^{16} thermal neutron/sec cm^2 at the surface of moderator with a spallation neutron target of W or ^{238}U. (auth)

3720 (CONF-750947—) **Experimental methods for charged-particle irradiations. Proceedings of a symposium held at Gatlinburg, Tennessee on September 30, 1975.** Kramer, D. (ed.). (Atomics International Div., Canoga Park, Calif. (USA)). Sep 1975. 100p. Dep. NTIS $5.45.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

Six papers are presented resulting from an effort to define recommended procedures for conducting irradiation experiments for neutron radiation damage simulation. The topics include: (1) operation of Van de Graaff heavy ion facilities at Oak Ridge and the University of Pittsburgh; (2) design of a ring lens for producing uniform density ion beams; (3) design of a sample holder for determining temperature dependence of heavy ion-induced swelling; (4) a technique for determining sample temperatures in high voltage electron microscope studies of simulated neutron damage; and (5) a high temperature, high vacuum facility for Van de Graaff heavy ion simulation studies. A separate abstract was prepared for each paper for Nuclear Science Abstracts (NSA) and for Energy Research Abstracts (ERA). (PMA)

3721 (CONF-750947—, pp 1-14) **High Energy Ion Bombardment Simulation Facility at the University of Pittsburgh.** McGruer, J.N. (Univ. of Pittsburgh, PA); Choyke, W.J.; Doyle, N.J.; Spitznagel, J.A. Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

The High Energy Ion Bombardment Simulation (HEIBS) Facility located at the University of Pittsburgh is now operational. The E-22 tandem accelerator of the Nuclear Physics Laboratory, fitted with a UNIS source, provides the heavy high energy ions. An auxiliary Van de Graaff accelerator is used for the simultaneous production of He ions. Special features of the simulation laboratory are reported. (auth)

3722 (CONF-750947—, pp 15-37) **Oak Ridge CN Van de Graaff Facility for heavy ion radiation damage studies.** Lewis, M.B.; McGowan, F.K.; Johnson, C.H.; Saltmarsh, M.J. (Oak Ridge National Lab., TN). Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

The Oak Ridge CN Van de Graaff accelerator was set up to deliver heavy beams useful for radiation damage studies. Beams of well defined energy, isotope, and charge state can be brought on target with an intensity in excess of 1 particle microamp, uniformly spread over a square centimeter area. Methods were devised to measure both the on-line intensity and uniformity of the heavy ion beam. (auth)

3723 **Bevalac: status of the machine and of the physics research program.** Hyde, E.K. (Univ. of California, Berkeley). *Phys. Scr.*; **10A**: 30-35(1974).

The Bevalac is briefly described and its schedule for completion is given. The Physics Research Program to be carried out with heavy ion beams with energy 0.250 to 2.1 GeV/nucleon is described. (auth)

3724 **Basic research in the Energy Research and Development Administration.** Teem, M.M. (Energy Research and Development Administration, Washington, DC). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 910-917(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Energy Research and Development Administration (ERDA) is responsible for a unified approach to planning, management, and funding of six primary activity areas: (1) fossil energy; (2) nuclear energy; (3) environment and safety; (4) conservation; (5) solar, geothermal, and advanced energy systems; and (6) national security. Basic research supported by ERDA should be evaluated with respect to the importance of new knowledge produced, but should also be able to contribute to applied needs in all six areas. Heavy ion research has benefited several areas, contributing to materials studied of simulated neutron damage, ion implantation for semiconductor and memory device fabrication, and the use of accelerated beams in medical research, radiography for example. ERDA has budgeted FY 1976 funds for two heavy ion facilities, the major facility at Oak Ridge and the additional construction at the SuperHILAC, Berkeley. It is recommended that future budgets provide for a 15 GeV positron electron colliding beam facility (PEP) at SLAC, full scale models of superconducting magnets for a proposed 200 GeV proton-proton colliding beam facility at BNL, and, as long term goal, a several thousand GeV accelerator at Fermilab. (PMA)

3725 **Operating results from Fermilab.** Livdahl, P.V. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 929-935(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The work of the entire Fermi National Accelerator Laboratory is reported, including the status of proposals and experiments, the scope of the research program, and the performance of the accelerator. The status of facility components are also discussed, covering: (1) the main accelerator; (2) the preaccelerator; (3) the linac; (4) the booster system; and (5) the extraction and switchyard system. Two advanced accelerator projects are reviewed, an energy saver/doubler magnet system and the development of a superconducting power transmission line. (PMA)

3726 **Recent progress on SLED, the SLAC energy doubler.** Farkas, Z.D.; Hogg, H.A.; Loew, G.A.; Wilson, P.B. (Stanford Linear Accelerator Center, CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1299-1302(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The recent discovery of psi particles has added further incentive to the search for ways of increasing the beam energy at SLAC. Several schemes for achieving higher energies have been explored in recent years. The system which has become known as SLED (SLAC Energy Doubler) has received ERDA approval for gradual installation, using Accelerator Improvement Funds. As presently conceived, SLED has the advantage that it will not increase the average power consumed by the accelerator, and is therefore compatible with national energy-conservation goals. Peak rf power will be enhanced at the expense of rf pulse length, so that the accelerator will deliver shorter pulses of higher-energy electrons with a duty cycle a factor of ten lower than at present. The system is described, and it is shown that SLED raises the accelerator peak energy by 40 percent if the present 2.7 μs rf pulse length is used. The energy increase is 80 percent if the pulse length is extended to 5 μs. Performance at both pulse lengths is discussed. (auth)

BEAM DYNAMICS, FIELD CALCULATIONS, AND ION OPTICS

3727 (CONF-750947—, pp 38-40) **Ring lens for producing uniform density ion beams.** Johnson, C.H. (Oak Ridge National Lab., TN). Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

Frequently one needs to irradiate a circular target uniformly with a positive ion beam from an accelerator. The typical beam is peaked on the axis and has a more or less Gaussian radial distribution, so that it would be advantageous to be able to fold the tails of the Gaussian inward to give a uniform flux on the target. A lens, which is quite unconventional, was designed and built for that purpose and has operated successfully for many months on the 5 RV electrostatic accelerator at this laboratory. The general concepts and lens structure are presented here. (auth)

3728 (JINR—P11-8982) **Program for solution of a system of integral equations of the first type describing the curved shim magnetic field.** Banchev, V.Ts.; Vorozhtsov, S.B.; Zhidkov, E.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A package of subroutines for the numerical solution of the inverse problem for determination of the magnetization and the dimensions of curved shims with a given magnetic field is proposed. (auth)

3729 **Positioning tolerances of beam line magnets.** Carey, D.C. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1537-1539(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The positioning tolerances of magnets are an important consideation in the design and installation of a beam line. A misaligned magnet can both shift the beam centroid and affect the beam line transmission characteristics. To first order and without misalignments, the coordinates at any point of a beam particle are given as a transfer matrix times the initial coordinates. To this is added a term linear in the misalignment parameters, giving the beam centroid shift, and a term bilinear in the initial particle coordinates and the misalignment parameters, giving the effect on the beam focal properties. This formalism has been incorporated into the computer program TRANSPORT. The effect of either a known misalignment or an uncertainty in position may be exhibited. In a single run, up to ten magnets may be separately misaligned, and their separate effects on the beam coordinates printed in a table. (auth)

3730 **Beam calculations for LAMPF muon channel.** Lysenko, W.P. (Yale Univ., New Haven); Hughes, V.W.; Ohnuma, S.; Thompson, P.A.; Vogel, H.F. *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1593-1597(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Calculations are described of the beam properties of the stopped muon channel at LAMPF with emphasis on work done during 1974 which was helpful in tuning the muon channel for maximum performance and for understanding the channel behavior. Comparison with actual channel performance during this period and some notes on the computer programs used are also presented. (auth)

AUXILIARIES AND COMPONENTS

3731 (CONF-750947—, pp 41-50) **Techniques for rapid screening of the swelling characteristics of ion-irradiated metals.** Taylor, A. (Argonne National Lab., IL); Stubbins, J.; Moteff, J. Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

Heavy-ion bombardment of prospective nuclear reactor metals has yielded large quantities of data concerning void-swelling susceptibility. To mitigate several of the experimental complications with charged-particle irradiation, a temperature-gradient target holder was developed for quick, efficient screening of the temperature dependence of void swelling. This specimen holder was designed so that three specimen foils could be held in the same temperature gradient during irradiation. Postirradiation studies of the surface topography (step-height measurements) and the void microstructure of one specimen yields information on the void swelling as a function of temperature. (auth)

3732 (CONF-750947—, pp 82-97) **High temperature, high vacuum facility for heavy ion simulation studies.** Lott, R.G.; Smith, H.V. Jr. (Univ. of Wisconsin, Madison). Sep 1975.

From Symposium on experimental methods for charged-particle irradiations; Gatlinburg, Tennessee, USA (30 Sep 1975).

In Experimental methods for charged-particle irradiations.

A high vacuum irradiation facility for heavy ion simulation studies with a tandem accelerator is described. Specimen irradiations are performed at vacuums of less than 10^{-8} Torr. The samples are heated to temperatures as high as 1100°C by a thermal radiation heater. Partial pressure analysis reveals that H_2, H_2O and CO are the main constituents (approximately 97 percent) of the vacuum. Smaller amounts of CO_2, CH_4 and C_2H_4 (approximately 3 percent total) are also present. Beam charge state distribution and beam purity are measured by Rutherford scattering from a gold foil. Beam current densities and profiles are also measured. (auth)

3733 AGS beam loss monitoring system. Levine, G.S.; Balsamo, J.C. Jr. (Brookhaven National Lab., Upton, NY). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1069-1071(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The usefulness of a beam loss monitoring system in diverse aspects of accelerator operation is documented with a variety of examples. (auth)

3734 Calorimetric determination of beam energy. Miller, G.H.; Lockwood, G.J. (Sandia Labs., Albuquerque, NM). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1072-1075(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A high-precision calorimetric system was developed for determining beam energy. The beam is square-wave (on-off) modulated and the time derivative of the calorimeter temperature is determined at a time late in the modulation half-cycle. This avoids sensitivity variations associated with beam size and location on the calorimeter. The data are collected and analyzed in a small on-line computer. The use of beryllium, with its very small backscatter coefficient for electrons, permits the use of the method for electron accelerators. Using such a calorimeter with a high-stability electron accelerator, standard deviations of the order of 0.03 percent for series of 20 measurements were achieved for energies from 0.025 to 1 MeV over several hours time period. The calorimeter system is usually calibrated with a low energy (approximately 20 keV) positive ion beam whose energy is well established. Where lower accuracy is acceptable, the sensitivity may be determined from first principles to within 1 percent. The method is described, and the optimization of the various parameters is discussed. (auth)

3735 Control through a system of small computers. Mallory, K.B. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1086-1087(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The system status and executive programs are discussed for the computers used in the control of the linac at SLAC. A continuing traffic study is maintained of the flow of tasks within and between CPUs and of the use of resources such as the disk, links, interfaces, and internal I/O buffers. The study shows that the computers in the control system are idle much of the time. By controlling the peak traffic, many occasional tasks can be added as additional computer aids to the accelerator operators. (PMA)

3736 Improved design for the Fermilab septal. Walton, J.; Andrews, R.; Edwards, H.; Palmer, M. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1091-1093(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Thin electrostatic septa are the most critical elements of the main ring extraction system and the beam splitting stations at Fermilab. Operating experience since the first extracted beam in 1972 has indicated several improvements needed over the original septa for both extraction (single cathode) and beam splitting (double cathode). A second generation of septa, now being implemented, is described here. (auth)

3737 Radiation hardened proton meter for Fermilab external beam lines. Kerns, C.R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1104-1108(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A beam line current and charge monitor has been in use for several months with the following characteristics: (1) beam toroid in high radiation area 200 feet from electronics, and within 30 feet of the 140,000 ampere pulsed neutrino horn; (2) response time adequate to permit accurate (1 percent) measurement of 1 turn fast-extracted beam; (3) digital and analogue readouts for full scale ranges of 2×10^{12}; 1×10^{13}, and 5×10^{13} protons per pulse; (4) computer readout and standardization via CAMAC; and (5) pulse-to-pulse repeatability is 1 in 1000 on test pulses. There is no interference from the horn, which pulses at the same time as the beam. (auth)

3738 Fermilab energy doubler, a two-year progress report. Fowler, W.B.; Drickey, D.; Reardon, P.J.; Strauss, B.P.; Sutter, D.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1125-1128(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Work was begun about 2-1/2 years ago at Fermilab on feasibility studies for the Energy Doubler/Saver. This activity has centered on the technology of building Energy Doubler/Saver magnets and their cooling system. Energy Doubling would be accomplished by installing in the 4-mile tunnel of the Fermilab accelerator a ring of superconducting magnets. Energy Saving would use the same ring of superconducting magnets operating in a power saving mode. The motivation for the saver would be to obtain the same energy, intensity, and duty cycle of the present machine, but with a significantly reduced electrical power bill. (auth)

3739 Performance studies of superconducting dipoles for the Fermilab energy doubler. Drickey, D.; Flora, R.; Strauss, B.P.; Sutter, D.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1137-1140(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Energy Doubler magnet development and testing program was initiated in September 1972 and has thus far proceeded through three phases. In the first phase, several wire winding geometries and the ability to reproduce magnet field properties in a pair of dipoles were explored. This phase closed with construction and operation of a 20 foot dipole magnet. When the 20 foot magnet did not perform to expectations, phase 2, a program of 2.5 foot prototype construction, was initiated. Twelve 2-1/2 foot magnets were tested to evaluate problems of excessive training and failure to go to short sample. Sufficient information was gained about mechanical structure, wire properties and coil cooling from these studies to cause an extensive redesign of the basic Energy Doubler dipole magnet. Construction of the first magnet of new design, C1-2.5, in October of 1974 marked the initiation of phase 3 of our program. Three magnets were completed: C1-2.5, a 2-1/2 foot magnet, went to 40 kG mounted in a horizontal cryostat with warm iron. C2-2.5 was used to explore some special concepts of coil confinement, and C2-10 was tested by a 12,000 cycle test and excitation to 25 kG without iron as a demonstration of a magnet that would allow operation of the Doubler from 100 to 500 GeV in the "Energy Saver" mode. (auth)

3740 Magnetoresistance elements for the measurement and control of harmonics in superconducting accelerator magnets. Sampson, W.B.; Robins, K.E.; Thomas, M.G. (Brookhaven National Lab., Upton, NY). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1157-1159(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A system for continuously monitoring the harmonic coefficients of a superconducting accelerator is described. The method employs a series of magnetoresistance elements placed at specific locations around the circumference of the usable aperture. Difference signals from these probes are used to determine the harmonic coefficients. This method does not require integration of the field measuring signals or rotation of the probes, so the elements can be built into the magnet during construction. Experimental results are given for the simplest configuration and these results are compared to the sextupole signal measured in a more conventional way. (auth)

3741 Electrical protection of superconducting magnet systems. Sutter, D.F.; Flora, R.H. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1160-1163(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The problem of dissipating the energy stored in the field of a superconducting magnet when a quench occurs has received considerable study. However, when the magnet becomes a system 4 miles in length whose normal operation is an ac mode, some re-examination of standard techniques for dissipating energy outside the magnets is in order. Data accumulated in the Fermilab Energy

Doubler magnet development program shows that heating associated with the temporal and spatial development of quenches is highly localized and can result in temperatures damaging to the superconducting wire. The design and operation are discussed for several energy dumping schemes, compatible with the operation of ac superconducting magnets, wherein more than 70 percent of the stored energy can be dissipated outside the magnet. Instrumentation to detect quenches early in their development and circuits for dumping the field energy are described, and representative operating performance data for the dump circuits and data showing temporal development of quenches are presented. (auth)

3742 ESCAR helium refrigeration system. Byrns, R.; Green, M.A. (Univ. of California, Berkeley). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1168-1171(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The ESCAR cryogenic system, with its two distribution loops offers many advantages. The system models the kind of system that can and should be used in future accelerators. The refrigerator cold box, with its turbine expanders, and the helium screw compressor system represent a significant step in the development of reliable helium refrigeration systems. (auth)

3743 Thermal conductance measurements of mechanical supports for superconducting magnets. Kuchnir, M.; Sanger, P. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1183-1184(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The space confinement and warm iron shielding envisioned for the superconducting magnets of the Fermilab Energy Doubler impose high demands on the insulating support system with regard to stiffness and thermal conductance. In order to adjust the minimum heat load to a reasonable refrigeration power, a study of the heat conduction through the support was undertaken. The use of multilayer insulation can reduce the infrared radiation load to a small fraction of the conduction load. A study was made of the design of several possible supports, steady-state thermal analysis calculation for two supports, and the development and use of a new method for measuring their thermal conductances. The thermal conductance measurements are discussed in detail. (auth)

3744 Operation of superconducting magnets in Fermilab extracted beams. Rode, C.; Gavin, P.; Norton, R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1185-1187(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The design and layout of the refrigeration, transfer, and magnet systems are discussed. Data on heat leaks and beam losses are presented (auth)

3745 Fermilab energy doubler magnets: magnetostatics. Snowdon, S.C. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1206-1210(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Magnetic field computations were performed for the three-inch circular aperture doubler magnets in the warm iron geometry. Locations for rectangular conductors along circular arcs were found such that, in the absence of the construction errors, the sextupole and decapole terms have been removed from the dipole. For the quadrupole, suitable locations for the conductors were found that remove the duodecapole term. Field quality, longitudinally integrated fields, construction errors, forces, energy content, and eddy current heating under cycled conditions are discussed for a 45 kG dipole and a 20 kG/inch quadrupole. (auth)

3746 Design and performance aspects of a precision high-current power supply. Cilyo, F.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1238-1241(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Ferrite Bias Supply, in essence, is an error power amplifier in the resonant cavity frequency tuning system. As such, it accepts inputs from a programmed voltage source and from a phase detector. In response to these input signals, it produces dc current in the tuner windings as required for resonant frequency. The resulting amper-turns saturate ferrite cores, changing the inductance and the resonant frequency of the cavity. Because of its strategic location, the performance and operational requirements on the bias supply are severe. There are 16 bias supplies in the booster and 16 in the main accelerator, with additional units to be added. (auth)

3747 Multiple flattop control system for the Fermilab main accelerator power supplies. Cassel, R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1247-1248(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Fermilab Main Accelerator was originally designed to operate with a bending magnet guide field consisting of an injection period, a linear acceleration period, a single extraction period called a "flat-top" and an "invert" or recovery period. The same cycle would then be repeated at a fixed repetition rate. The main power supply system was designed and has been operating under those constraints for several years. With the advent of additional beam lines and numerous experiments, the single extraction energy and repetition cycle has become restrictive and wasteful of energy and accelerator operating time. The nonregulated recovery period has resulted in difficulties with injection remnant fields. The existing hardware consisting of individual waveform generators for each power supply was not sufficiently flexible to allow for variations in the number of flattop periods per cycle or variations cycle to cycle. A new program to control the main accelerator power supplies was undertaken to provide sufficient flexibility to generate multiple "flattops" and multiple cycles with detailed shaping and regulation of the recovery period. A further goal of the new program was to make generation of a new program simple and fast. (auth)

3748 Design and operation of the SPEAR II rf system. Allen, M.A.; Ecken, R.A.; Genova, L.; Humphrey, B.E.; Karvonen, L.G.; Konrad, G.T.; Lebacqz, J.V.; McConnel, R.A.; Olson, C.W. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1269-1272(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The SPEAR storage ring was initially designed to operate at an energy of 2.5 GeV but with a capability built into the magnets for operation above 4.0 GeV. To operate at these high energies, a completely new rf system was necessary. Four straight sections were available to provide the over 7 megavolts of rf necessary. A frequency of 358 MHz was chosen, and a decision was made to use klystron amplifiers for the power tubes. (auth)

3749 Dc chopper used as an adjustable current bypass shunt. Berndt, M.; Guracar, C.; Lipari, J. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1273-1276(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

In a synchrotron machine of the separated function magnet type, if the quadrupole magnets can be made to change exactly together with the bending magnets, the result will be no shift in the betatron tunes, but only a shift in energy. In the SPEAR ring this feature is used to advantage. Selected groups of quadrupoles that have a particularly pronounced effect on the machine tunes were designed to operate at a current slightly less than the bending magnet current. These quadrupoles are then energized in series with the bending magnets, except for an adjustable current bypass shunt, capable of diverting up to 20 percent of the total current. (auth)

3750 Transductors for current sensing in the dipole and quadrupole magnet circuits of the Fermilab main ring. Kerns, Q.A. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1277-1280(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Transductors are used as current measuring devices in the main accelerator quadrupole power supply feedback loop and as monitors in the dipole circuit. The development of these transductors is described, starting with the basic series—connected (Kraemer) transductor circuit, and adding the features of biasing and a voltage follower to obtain improved linearity and high slewing rate. (auth)

3751 Dielectric property measurements on large alumina vacuum seals used on Fermilab accelerator rf cavities. Bridges, J.F.; Johnson, D.E.; Griffin, J.E. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1296-1297(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The rf window vacuum seals on the 400-GeV Fermilab accelerating rf cavities are very large circular cylinders of alumina. The cavities were first installed with seals of 94 percent purity Al_2O_3. Several of these seals failed in high-power operation due to dielectric heating. Higher purity ceramics (99.5 percent Al_2O_3) were obtained and are now being installed. The complex permittivity of both types of ceramic was measured in a TM_{010} mode test cavity ten inches high and eight feet in diameter. Frequency shift and Q shift data were analyzed by perturbation analysis and by computer programs. Results confirm that the higher purity ceramics have a loss tangent a factor of five better than the original seals. Some high-power operational test results are also presented. (auth)

3752 Power supply system for beam steering. Gano, J.J. (Massachusetts Inst. of Tech., Middleton). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1311-1312(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The power supply system for steering the Bates Linac beam provides continuous adjustment of the current from +2.5A to -2.5A per pair of coils at +-25 volts. A simple, inexpensive system has been assembled from off-shelf components. Separate controls for 26 pairs of coils are provided by means of power operational amplifiers and drivers connected in series with the coils across a common pair of +-30 V busses. No current regulation is used. After coils and amplifiers have reached thermal equilibrium (about one-half hour at 2.5A) the current is stable within 0.5 percent. (auth)

3753 230 kJ pulsed power supply. Winje, R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1317-1320(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Meson Focussing System (Horn), consisting of two single-turn coaxial structures, in which circular magnetic fields of varying intensity are produced, and a 230 kJ pulsed power supply, was built and operated at Fermilab. The development and construction of the power supply and its related control system are reported. The capacitor discharge series resonant network was chosen because of the ability to generate the required high current at a relatively modest voltage. Ignitrons are used as the switching elements. A dual set of ignitrons and their controls are connected to the capacitor bank which allows the time-shared operation of the power supply into two loads without the necessity of mechanical, high-current switching. The alternate load for the power supply is a test area where development work on new horn system components is carried out. (auth)

3754 Status report on klystron improvements. Lebacqz, J.V. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1324-1327(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A program of improvements of the high power pulsed klystrons used in the gallery at SLAC, originally designed to operate at 250 kV with a peak power output of between 21 and 24 MW is reported. The design of a new high efficiency klystron is reviewed, including special requirements for electromagnets and interlocks for focusing the tubes, as well as the performance of the first two sectors. The operating life experience of all high power pulsed klystrons used at Stanford is discussed. (auth)

3755 Interaction of accelerator controls and diagnostics. Shea, M.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1458-1465(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Computer control systems have been in use on operating accelerators for several years. A discussion and some examples are given of ways in which control-system equipment can be used by accelerator engineers and physicists to study beam properties and operating characteristics of accelerator components. (auth)

3756 Fermilab transverse instability active damping system. Higgins, E.; Kerns, Q.; Miller, H.; Prichard, B. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1473-1474(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A system for controlling vertical single bunch instability is described. The vertical position of each of the 1113 bunches in the Fermilab Main Ring is digitized and stored in a memory. After an interval determined by counting rf cycles, the memory is read. The delayed position signal is sent to a distributed amplifier. A transmission line serves as a beam deflector. (auth)

3757 Fermilab neutrino: horn focussing system. Nezrick, F.A. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1479-1483(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

To increase the flux of neutrinos at the Fermilab accelerator over the entire neutrino energy spectrum, a high efficiency horn-focussed beam was developed. The horn system is well known for its high acceptance and highly achromatic focussing of charged particles formed at the production target into a low divergence beam. This meson beam is allowed to decay in a 400 m long vacuum region producing neutrinos and muons. The muons are absorbed from the beam by using 1 Km of earth, allowing the filtered neutrino beam to pass through the experimental detectors. The equipment and results of the focussing region are discussed. (auth)

3758 Variable-length time delay for 50 MHz sampled analog signals. Biwer, R.; Tool, G. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1509-1512(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A Super Beam Damper which makes independent corrections to each of the 1113 beam bunches in the Fermilab Main Accelerator was built to damp vertical instabilities at high intensity. As the 53 MHz beam bunches pass a point in the accelerator, a position measurement made for each bunch is delayed for one turn around the accelerator (21 μsec) and is then applied to a correction device when that bunch arrives. This process occurs continuously for each bunch. The 1-turn signal delay hardware is described. (auth)

3759 Beam position measurement system at the Fermilab main accelerator. Kerns, Q.A. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1513-1516(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The beam position system of the Fermilab Main Ring contains one horizontal and one vertical Electrostatic Beam Pickup in each of the 96 cells of the machine. A pair of 75 ohm cables transmits the induced signal from the machine tunnel to the nearest service building. In each of the 24 service buildings, there is a solid-state multiplexer and a beam position detector which processes the A-B signal pairs to produce an intensity-normalized voltage proportional to beam displacement. This voltage is digitized, read into buffer of the Lockheed MAC A, and in turn transferred to the Xerox 530. Horizontal or vertical orbits can be obtained in 50 millisec. Orbits are obtained at injection and at a Main Ring Sample time, if requested, anywhere on the acceleration cycle. Injection orbits can be flattened automatically by a program that sets dipole trim magnets. (auth)

3760 Calibration of the beam-spill control system at LAMPF. Parker, J.R.; Liska, D.J. (Los Alamos Scientific Lab., NM). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1517-1521(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A technique is described for in-situ calibration of the beam-spill control system at LAMPF. Radiation produced by intercepted beam at the wire scanners is employed as a test source. It is shown that the secondary emission current from the wire scanner is a useful measure of the intercepted beam. The wire scanners are inserted into the beam by a digital-data servo system until the desired level of radiation is produced. Interesting digital-data servo-loop responses are displayed. The entire calibration procedure is programmed by the accelerator control computer and can be repeated as often as required without turning off the beam. The calibration programs have been written so that the conditions of the detectors and signal cables are determined and recorded. (auth)

3761 New pulse magnet design utilizing tape wound cores. Brunk, W.O.; Walz, D.R. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1548-1551(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Pulse magnets were built using tape wound cores in order to lower magnet power requirements at high pulse repetition rates and at high gap flux densities. The primary reason this project was undertaken was to bend higher energy beams with existing power supplies. A decrease in the amount of electrical steel from 2720 kg for the original laminated core pulse magnet design to 260 kg and the elimination of the ceramic vacuum chamber resulted in substantial savings. Two new magnets are now operational with the capability of deflecting 40 to 50 GeV/c beams through +- 0.35° (6.13 mrad) at a PRR = 360 pps. The old magnets with the same power supplies could only bend 21 GeV/c beams through the same angle. Principal features of this design, including test data, are presented. (auth)

3762 Fast digitizer and display system. Tool, G. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1567-1569(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Turn-by-turn information about beam characteristics in an accelerator is a valuable diagnostic aid to accelerator study and development. A fast Digitizer and Display System was built which takes up to four simultaneous "snapshots" of beam or related parameters during 256 consecutive passes at one or more detection points in the accelerator. The four digitizers may be separated by hundreds of feet so they can be located near the signal source. Each digitizer is connected to a central receiver unit by a single coaxial cable, so distance is limited only by attenuation in this cable. The system is used for Fermilab Main Accelerator development and injection tuning in which the measurement period is 21 μsec. It is capable of digitizing every 1.5 μsec for use on sequential turns of the Fermilab Booster Accelerator. (auth)

3763 High-speed beam position electronics for accelerator control and diagnostics. Higgins, E.F.; Griffin, J.E. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1574-1577(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Fast beam position electronic processing devices are an integral part of the on-line and diagnostic components for the Fermilab accelerator. Devices were developed which do not depend on repetitive beam signals for their operation, so that they are useful for analysis of both circulating beams and single beam passage (as in beam injection, transfer, or extraction). A capsule description is given of each type of position device, together with their relevant parameters. (PMA)

3764 53 MHz randomly triggered synchronous predetermined scaler for accelerator diagnostics. Higgins, E.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1578-1580(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A 53 MHz random triggered recycling, predetermined start-stop scaler is described. The scaler has a range from 2-to-9999 counts, sensitivity of 40 mV rms, and provides both NIM and TTL standard logic outputs. The scaler is composed mainly of standard ECL integrated circuits including universal counters, configured in a "synchronous parallel carry" connection, and ordinary logic gates and flip-flops. Special circuitry was designed to prevent start-up counting errors due to the phase randomness between the applied start triggering and input signal transitions. Following a start trigger, the scaler cycles until disabled, delivering an output pulse each time the predetermined count is reached. The time jitter of the output pulses with respect to the periodic input signal is less than 0.1 ns. High resolution examination of the behavior of individual charge bunches within the accelerator is made possible when the scaler is set one digit away from the harmonic number, the output pulses advance one bunch for each turn around the machine, allowing a sequential display of the contents of each bucket in the machine. (auth)

3765 Beam signal processing for the Fermilab longitudinal and transverse beam damping systems. Higgins, E.F. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1581-1585(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A beam signal processor is used to secure the position of each charged bunch in the Fermilab main synchrotron. The signal processor operates at 317 MHz, 6 times the fundamental beam component and uses an amplitude-to-phase converter/hard limiter combination to obtain a normalized position signal. The normalization process is complete in less than 10 ns and is effective over a 23 dB intensity range. The methods used to sample and process the 2 ns beam signal are discussed, and the principle parameters of the device are listed. The processor outputs the derived position data to elements in a closed-loop beam damping system. (auth)

3766 LLL 100-MeV electron linac: design considerations and performance of the beam-transport vacuum system. Lara, M.C.; Brooks, H.E. (Univ. of California, Livermore). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1609-1612(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The vacuum system is described for the beam-transport lines used with the Lawrence Livermore Laboratory 100-MeV electron-positron linear accelerator. It is operated in the high (10^{-4} to 10^{-5} Pa) range using standard ion pumps with turbomolecular pumps for roughdown. The important factors considered during the initial design phases are reviewed; these factors contributed to the very reliable performance of the vacuum system since its start-up five years ago. The cleaning and handling procedures used on the beam-transport lines, magnet vacuum chambers, and other vacuum components are discussed. (auth)

ION SOURCES

3767 (CONF-751048—1) **Production of positive ion beams from solids.** Hudson, E.D.; Mallory, M.L.; Lord, R.S. (Oak Ridge National Lab., Tenn. (USA)). 1975. 4p. Dep. NTIS $4.50.

From International conference on heavy ion sources; Gatlinburg, Tennessee, USA (27 Oct 1975).

A technique for making metal ions for cyclotrons is described. Metal and non-metal ions from solids are produced in a Penning ion source by a process that involves ions that are unable to cross the first acceleration gap between the ion source and dee and are accelerated back into the ion source where they sputter charge material into the arc. This material is ionized and extracted from the ion source and accelerated. This technique was used for a large variety of ions, both metal and non-metal, including aluminum from the metal and boron from boron nitride charge materials. The efficiency for making iron ions with different ion support gases was calculated, and these results were experimentally checked. A dual ion source is being designed for a dc Penning ion source test stand which makes an excellent source for producing ions from solids for dc extracted Penning ion sources. (auth)

3768 (CONF-751048—2) **Penning multiply charged heavy ion source test facility.** Mallory, M.L.; Crandall, D.H. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. 4p. Dep. NTIS $4.50.

From International conference on heavy ion sources; Gatlinburg, Tennessee, USA (27 Oct 1975).

An ion source test facility was constructed for making fundamental measurements of the properties of Penning ion sources. The extracted ion energies from the source can be up to 36 x q (keV), where q is the ion charge. Both negative and multiply charged positive ions were extracted from the source. The facility has high current capabilities for acceleration and for the arc power supply. These low-energy, multiply charged ions are currently being used for measurements of charge exchange cross sections, x-ray production, and electron impact excitation and ionization. (auth)

INJECTION AND EXTRACTION SYSTEMS

3769 Precision current transductor for the Fermilab booster magnet power supply. Dinkel, J.A.; Donaldson, A.R. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1234-1237(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The Fermilab Booster synchrotron requires precise injection and extraction field regulation (+- 0.001 percent repeatability). To achieve this tolerance with a current regulator requires that the current measuring device have a high degree of resolution, stability, and a high output level. To meet this criteria, a transductor using the second-harmonic magnetic modulator technique was chosen. This device is capable of better than +- 0.001 percent measurements from dc to 15 Hz for currents from 50 to 1200 A. Small signal (approximately 100 A peak-to-peak) response is 3 db down at 10 kHz. The conversion gain was chosen as 1 V/121.25 A

to permit operational amplifier compatible signal levels at the output. (auth)

3770 110 kA rapid-pulsing power supply. Winje, R.; Bourkland, K. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1242-1246(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The multi-turn injection of 200-MeV protons into the Fermilab 8-GeV Booster Synchrotron requires the shifting of the closed orbit towards the inflector septum. This local orbit bump is produced by a symmetrical arrangement of two double-bend magnets; one increasing the radius of the beam, the second decreasing the radius. The load for the power supply consists of these two identical magnets, one located at the upstream end of the booster injection girder, and the other at the downstream end of the injection girder. Each magnet assembly consists of two magnets connected in parallel in such a manner as to provide equal but opposite magnetic fields. The amplitude of the closed orbit shift is required to decrease as each successive turn is injected. For optimum efficiency, the rate of decay of the magnetic field should be linear. A good approximation can be achieved from a sine curve in the region from $5/6\ \pi$ to π. The power supply which is used to furnish excitation currents to the orbit bump magnets is designed as a series resonant, capacitive discharge system with thyristor switches. (auth)

3771 Pulsed extraction magnet system at the Zero Gradient Synchrotron (ZGS). Knott, M.; Lewis, L.; Potts, C. (Argonne National Lab., IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1313-1316(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Pulsed operation of six extraction magnets saved $67,000 in FY 75. Conversion of four six-phase supplies involved some unique analog circuitry. A minicomputer operated function generator provides control of up to 20 magnet power supplies with new dI/dt data available every 4 ms. The operator control console has several options which appreciably decrease set up time and decrease operator error. (auth)

3772 Nanosecond electron beam generation and instrumentation at SLAC. Koontz, R.F.; Miller, R.H. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1350-1353(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The present SLAC injector system, including the latest beam chopping equipment, is discussed, and an updated diagram is given. The present equipment can produce almost any mix of chopped and single bunch beams for experimenters with a high degree of multiple beam compatibility. Topics covered include the grid pulsers, the pulse isolation transformers, the resonant choppers, the nonresonant chopper, the synchronization system, and the fast beam monitors. (PMA)

3773 Zero Gradient Synchrotron booster injection. Suddeth, D.E.; Kustom, R.L.; Schmitt, D. (Argonne National Lab., IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1488-1491(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Due to the large radial aperture of the Zero Gradient Synchrotron (ZGS), it seems reasonable to stack two booster beam bunches in the radial betatron phase space. This requires some manipulation of timing and intermediate kicks to accomplish the task. Fourth harmonic operation was selected, which fitted best the kicker flux rise times and the injector energy spread. The accelerating voltage frequency will be 5.3 MHz, which gives a beam bunch every 188 ns. The beam length will be 94 ns. (auth)

EXPERIMENTAL FACILITIES AND EQUIPMENT

3774 (CONF-751115—2) **Design of the Fermilab remote target maintenance system.** Simon, J.; Grimson, J.; Lindberg, J.; Theriot, D. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jul 1975. 31p. Dep. NTIS $4.50.

From 23. conference on remote systems technology; San Francisco, California, USA (16 Nov 1975).

A system of interchangeable targetry on rail transporters, in use for four years, is described. The design concept allows rapid interchange of radioactive target equipment with a minimum of exposure to operating personnel. Separate maintenance facilities, equipped with a variety of remote handling equipment including a mobile electric master slave manipulator, are used to construct, maintain, and modify targetry and beam line equipment concurrent with the 400 GeV accelerator beam operation. (auth)

3775 (CONF-751115—4) **Design of the Fermilab neutrino horn train system referenced to radioactive maintenance.** Grimson, J.; Lindberg, J.; Simon, J.; Theriot, D. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Jul 1975. 40p. Dep. NTIS $5.00.

From 23. conference on remote systems technology; San Francisco, California, USA (16 Nov 1975).

A high energy physics device known as a Horn, operating at 140,000A and 8 kV, has unique servicing problems after being exposed to 300-400 GeV protons at 1-5 x 10^{13} protons/pulse. A modular system consisting of two horns, one cooled by a pulsed water spray, the other by forced air cooling, along with their associated utilities and instrumentation, were designed for primary servicing using Electric Master Slave Manipulators and TV viewing. (auth)

3776 (BNL—20518) **Production of neutrons and secondary protons with particle accelerators.** Kukkonen, J. 1973. Translation of Sekundaarineutronien ja -protonien tuottaminen hiukkaskiihdyttimillae. 350p. Dep. NTIS $10.00.

Thesis.

Methods of producing fast neutrons and secondary protons are discussed, and related information, such as yields and target temperatures, is included. To widen the use of small electrostatic accelerators, the possibility of producing 15-MeV protons is treated. The fraction of the particles emitted by the source which hit a plane sample (the hitting efficiency) was determined in a computer calculation for several geometries. Fast neutron production with accelerators operating at energies greater than 20 MeV is discussed, and new target concepts are introduced. (PMA)

3777 Liquid deuterium neutron attenuator for broad-band photon beam facility. Fast, R.W.; Otavka, M.A. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1201-1203(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The photo-production facility at Fermilab uses a two section liquid deuterium attenuator, 103 feet in length, to reduce the neutron flux and produce a pure high energy photon beam. The facility is located in the Proton East experimental hall, and includes nine 10 foot long sweeping magnets. A unique refrigeration system supplies mechanically refrigerated helium gas trace cooling to condense deuterium directly in a flask. The control system permits remote operation of the cryogenic system and also acts as an interface to the Proton Area operations computer. The computer can be used to monitor the operating parameters and for partial control of the system. The facility is presently in use as part of the Proton Area experimental program. (auth)

3778 Highly stabilized power supply for spectrometer. Gano, J.J. (Massachusetts Inst. of Tech., Middleton). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1229-1233(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The two 4000A, 150V power supplies for the spectrometer magnet of the Bates Linac have a current regulation and stability of better than .001 percent for an 8-hour period. Current sensing is accomplished by a 5-volt precision shunt. The output is programmed by a stable dc voltage reference with a 6-digit keyboard. The rate of current increase or decrease for controlling magnet excitation is adjustable up to a rate of 4000A per minute. Power dissipation in the 300 pass transistors of each supply is limited by automatically controlling the emitter to collector voltage with the use of a variable voltage transformer. To avoid possible conducted or radiated interference with experimental signals, no silicon-controlled rectifiers are used. The major portion of this article is devoted to an analysis of the stability. (auth)

3779 Rf separators and separated beams at SLAC. Fieguth, T.H.; Gearhart, R.A. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1533-1536(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

For particle momenta above approximately 5 GeV/c, the only effective means of separation by particle mass in secondary beams is using rf deflectors. Particle separation at proton synchrotrons requires the use of two rf deflectors. The beam structure at SLAC permits the use of a single deflector. (auth)

STORAGE RINGS

3780 Storage accelerator bending magnet without median plane symmetry. Parzen, G.; Jellett, K. (Brookhaven National Lab., Upton, NY). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1188-1189(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

An H-magnet with no median plane symmetry, in which all the current carrying coils lie below the median plane, was studied using the GRACY magnet program. This magnet has several possible advantages for use in a super-conducting storage accelerator. The field multipoles violating median plane symmetry were found to be small, and correctable with small correction coils. In addition, it was found possible to reduce these undesired multipoles considerably by shaping the iron pole face. (auth)

3781 Fermilab high-field option POPAE dipole: magnetostatics. Snowdon, S.C. (Fermi National Accelerator Lab.; Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1204-1205(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Magnetic field computations were performed for a four-inch coil aperture 45 kG dipole magnet that may be used in a high-field option of POPAE. A cold iron version utilizing flat pancake coils was explored to determine the magnetostatic effectiveness of a simple coil geometry. Suitable locations were found for rectangular blocks of conductors each consisting of 280 turns of .040 in. by .040 in. conductor. (auth)

3782 High efficiency, CW, high power klystrons for storage ring applications. Konrad, G.T. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1249-1252(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The 125 kW c-w klystrons were specifically designed for energy upgrading of the electron-positron storage ring, SPEAR II, at SLAC. Four tubes are required with an efficiency greater than 50 percent. The operating frequency is 358.54 MHz. The gain is approximately 50 db, the operating voltage is 41 kV, and the microperveance is 0.7. The klystron must be stable when working into an accelerator cavity VSWR as high as 2:1 at any phase angle. The calculated and experimental data to be presented include saturation and phase characteristics. A maximum efficiency of 57 percent was obtained, and the highest output power was 160 kW c-w at 42.5 kV. The design of a higher power version of this tube is presented. The rf power is 500 kw c-w at an efficiency exceeding 70 percent. The operating voltage and current are 62 kV and 11.5 A, respectively. The higher efficiency is obtained by inserting an additional cavity to make use of second harmonic bunching. Eighteen such klystrons are to be used in the proposed PEP storage ring. (auth)

3783 SPEAR II performance. Paterson, J.M. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1366-1369(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The single beam and colliding beam performance of the SLAC electron-positron storage ring SPEAR II is described. The sevenfold increase in harmonic number in SPEAR II in comparison to SPEAR I has made significant changes in single beam behavior. Strong synchrobetatron resonances and a new transverse instability are observed, and our first studies of these phenomena are described. Measurements on current dependent bunch lengthening are presented. (auth)

3784 Progress report on the POPAE design study. Collins, T.L.; Edwards, D.A.; Igebretsen, J.; Johnson, D.E.; Ohnuma, S.; Ruggiero, A.G.; Teng, L.C. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1411-1415(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

POPAE (Protons on Protons and Electrons) is a storage ring facility at the Fermilab on a scale suitable to permit the collision of 1000 GeV protons with 1000 GeV protons and with electrons of an energy compatible with that scale. A summary is gien of the work on the lattice and layout of the proton storage rings. Though the 1000 GeV physical scale is maintained, the design is developed in a 400 GeV context. The proton rings form a racetrack, the two long straight sections of which are each about 1 km in length. Each long straight section contains a number of matched lattice insertions, as well as uncommitted space for additional development. Depending on the assumptions made concerning the beam-beam limit (as yet unknown experimentally), maximum luminosities are calculated to be in the range from 10^{33} to 10^{34} cm^{-2} sec^{-1}. (auth)

3785 PEP injection system. Brown, K.L. (Stanford Univ., CA); Avery, R.T.; Peterson, J.D. *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1423-1425(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

A system to transport 10 to 15 GeV electron and positron beams from the Stanford Linear Accelerator and to inject them into the PEP storage ring under a wide variety of lattice configurations was designed. Optically, the transport line consists of three 360^0 phase-shift sections of FODO lattice, with bending magnets interspersed to provide achromaticity, convenience in energy and emittance definition, and independent tuning of the various optical parameters for matching into the ring. The last 360^0 of phase shift has 88 milliradians of bend in a vertical plane, and deposits the beam at the injection septum via a Lambertson magnet. Injection is accomplished by launching the beam with several centimeters of radial betatron amplitude in a fast bump provided by a triad of pulsed kicker magnets. Radiation damping reduces the collective amplitude quickly enough o allow injection at a high repetition rate. (auth)

3786 Compensation of chromatic aberration in a single period lattice. Edwards, D.; Ohnuma, S.; Teng, L.C. (Fermi National Accelerator Lab., Batavia, IL). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1426-1428(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The requirement of high periodicity (even periodicity two) in a storage-ring lattice imposes a strong restriction on the number and type of insertions that can be included. On the other hand, since the insertions are matched only at one momentum, the β-function error for an off-momentum orbit is generally greater in a one-period lattice. This large β-error has several undesirable effects. All of these undesirable effects can be compensated or greatly reduced by judicious arrangement of betatron phasing and by the use of trim sextupoles. The design procedure and the resultant performance are demonstrated for a model one-period lattice. (auth)

3787 Extrapolation of the ISABELLE design to 400 x 400 GeV. Chasman, R. (Brookhaven National Lab., Upton, NY); Gluckstern, R.L. *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1435-1438(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

Consideration of a national program for the development of new high energy facilities during the next ten years suggests that the most appropriate energy for proton storage rings may be higher than the 200 x 200 GeV of the present ISABELLE design. It has been indicated that 300 x 300 GeV or 400 x 400 GeV may provide a more reasonable step to maximize the scientific potential of the next major proton storage ring facility. A preliminary analysis of the design consequences of changing the ISABELLE energy to 300 x 300 GeV and 400 x 400 GeV is given, keeping the luminosity, maximum field, and most of the original design parameters unchanged. It is concluded that the ISABELLE concept can be extrapolated to 400 x 400 GeV without any unmanageable technical problems and that even higher energies seem to be feasible. (auth)

3788 Transverse oscillations damping with wide-band feedback on SPEAR II. Pellegrin, J.L. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1500-1504(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

With its high peak currents, SPEAR II is likely to show transverse coherent oscillations. A closed loop system, using the beams as a signal path, detects the bunch center-of-mass motion and reacts on the beams after one machine period with a set of traveling wave electrodes. The detector senses oscillations at the betatron frequency and rejects signals due to equilibrium orbit shifts. The amplifier output is solely determined by the desired gain and the detector noise. Since, for a given machine tune, the system phase margin can be made 90^0 by selecting the respective location of the pickup and feedback electrodes, stability is secured for all values of gain. However, critical damping cannot be ob-

tained except with infinite gain, and the system damping rate is strictly equal to the gain per turn. Measurements of the loop gain were carried out and agree with the observed damping. To date, the system was successful in dealing with injection oscillations and headtail instabilities. (auth)

3789 Vacuum system for the Stanford-LBL storage ring (PEP). Bostic, D.; Cummings, U.; Dean, N.; Jeong, B.; Jurow, J. (Stanford Univ., CA). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 3, 1540-1543(Jun 1975).

From Particle accelerator conference; Washington, District of Columbia, USA (12 Mar 1975).

See CONF-750335—.

The vacuum system for PEP will be similar in design, construction, and operation to the system currently in operation at SPEAR. There will be quantitative differences since the closed path of PEP will be 10 times longer than the SPEAR path. Some qualitative differences will also arise since the radiated synchrotron power for PEP will be about 13 times greater than for SPEAR, giving rise to an increased linear power density incident on the chamber wall. Other differences arise from the higher energy spectrum of the synchrotron radiation. The SPEAR vacuum system has been in operation since April 1972 and has proven satisfactory in design, construction, and operation. The chamber was subject to synchrotron radiation for approximately 300 ampere-hours and the beam lifetimes are now more than several hours. The details of the PEP design and the SPEAR operating experience are discussed. (auth)

INSTRUMENTATION

RADIATION INSTRUMENTATION

GENERAL DETECTORS AND MONITORS

3790 Multiwire proportional chamber foacl-plane detector. Beardsworth, E.; Fischer, J.; Iwata, S.; Levine, M.J.; Radeka, V.; Thorn, C.E. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods;* **127**: No. 1, 29-39(15 Jul 1975).

Multiwire proportional chambers with precise position resolution were developed utilizing external-tapped delay-line readout from a cathode and simultaneous dE/dx information from the anode for identification of particles ranging from protons to heavy ions in the focal plane of a high-resolution magnetic spectrometer (QDDD). A resolution of less than 0.2 mm fwhm was achieved for 48 MeV ^{16}O ions. (auth)

RADIATION DOSEMETERS

3791 (BNWL—1934) **Fifth ERDA workshop on personnel neutron dosimetry.** (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 72p. (CONF-750528—). Dep. NTIS $5.45.

From 5. workshop on personnel neutron dosimetry; Gaithersburg, Maryland, USA (6 May 1975).

Separate abstracts were prepared for 5 of the 15 papers presented. The 10 remaining papers were summaries of neutron dosimetry research work at various laboratories. (WHK)

3792 (BNWL—1934, pp 12-19) **Neutron dose measurements by electrolytic conductance in fission fragment damage tracks.** Cross, W.G.; Ing, H. (Atomic Energy of Canada Ltd., Chalk River). 1975.

In Fifth ERDA workshop on personnel neutron dosimetry.

The density of fission fragment damage tracks in a plastic foil exposed to neutrons against a radiator of fissionable material has been used for a number of years for determining neutron doses. Of the methods that have been developed for determining the number of tracks without having to count these under the microscope, spark counting appears to be the simplest and most accurate, providing that the track density is not too high. The very simple alternative method described is intended primarily for higher track densities than can be measured by spark counting. It depends on filling the etched tracks that penetrate the foil with electrolyte and measuring the electrical conductance through them. (WHK)

3793 (BNWL—1934, pp 20-31) **Calibration of the experimental BND personnel neutron dosimeter for general use.** Distenfeld, C. (Brookhaven National Lab., Upton, NY). 1975.

In Fifth ERDA workshop on personnel neutron dosimetry.

The experimental Brookhaven neutron dosimeter, BND, is a composite damage track and thermoluminescent detector. Thorium fission is used to respond to greater than 1 MeV and high sensitivity TLD 600 and 700 ribbons respond to softer neutrons. Previous experimental work at the Alternating Gradient Synchrotron, AGS, a 33 GeV proton accelerator, utilized the energy dependence of the ratio of thermoluminescent to thorium response, softness. Softness variation was related to a correction factor used to adjust a TLD response to properly account for the dose equivalent. An invitation was extended to participate in the 1974 Intercomparison of Personnel Neutron Dosimeters. The Oak Ridge National Laboratory study was similar to the standard nuclear accident dosimetry intercomparisons, but of lower dose magnitude. Neutron spectra of varying composition were generated by a 14 MeV neutron generator and the HPRR reactor in its three configurations. Participation in the study required the determination of different BND calibration constants for the much softer reactor spectra. The resulting study assumed that the high energy accelerator constants were properly specified. All remaining field spectra were assumed to be limited to approximately 15 MeV. For this case, the thorium calibration value was 7.1 mrem x $sparks^{-1}$ and the problem was the interpretation of the TLD response. Results are presented. (WHK)

3794 (BNWL—1934, pp 43-53) **Studies of neutron dosimetry at the Lawrence Livermore Laboratory.** Hankins, D.E. (Univ. of California, Livermore). 1975.

In Fifth ERDA workshop on personnel neutron dosimetry.

The evaluation of neutron exposures from LLL personnel TLD badges is discussed; and data are given and discussed on the calibration factors for albedo-neutron dosemeters as a function of the dose rate at various facilities. (WHK)

3795 (BNWL—1934, pp 54-57) **Response of Savannah River thermoluminescent neutron dosimeter to monoenergetic neutrons.** Hoy, J.E.; Hall, R.M. (E. I. du Pont de Nemours and Co., Aiken, SC). 1975.

In Fifth ERDA workshop on personnel neutron dosimetry.

The Thermoluminescent Neutron Dosimeter (TLND) is an albedo-type detector designed to respond in a manner a4proximately proportional to the dose equivalent. The dosimeter was intended to be used in a normal working environment where a complete spectrum of neutron energies occur and where monoenergetic neutrons are practically nonexistent. However, knowledge of the response of dosimeters to monoenergetic neutrons can assist in understanding the observed response to continuous spectra. (WHK)

3796 (BNWL—1934, pp 58-59) **NTA proton recoil track fading in personnel neutron dosimetry.** Phillips, L.F. (Brookhaven National Lab., Upton, NY). 1975.

In Fifth ERDA workshop on personnel neutron dosimetry.

Two Kodak NTA proton track fading studies were performed using two different types of sealing packets and storage at 100 percent relative humidity (R.H.). Results are summarized graphically. (WHK)

3797 (EUR—5358e) **Radiological protection-3. Technical recommendations for the use of thermoluminescence for dosimetry in individual monitoring for photons and electrons from external sources.** (Commission of the European Communities, Luxembourg). 1975. 2p. Dep. NTIS (US Sales Only) $5.75.

The advantages of thermoluminescence dosimetry for monitoring personnel are discussed. The properties of thermoluminescent detectors and sources of possible errors in thermoluminescent dosimetry are reviewed. (CH)

3798 Radiography of low-energy ion beams: hydrogen coloration of flint glasses. Primak, W. (Argonne National Lab., Ill. (USA)). *Nucl. Instrum. Methods;* **127**: No. 1, 21-22(15 Jul 1975).

Optical flint glasses (i.e., lead containing) develop an intense coloration when subjected to bombardment with protons or deuterons. The coloration is sufficient for the detection and measurement of ion beams penetrating less than a micron. The optical absorption is given as a function of wavelength and appears to be the tail of bands centered in the near ultraviolet. The optical density at 0.436 μm is given as a function of incident ion charge for 140 keV protons and deuterons and for 80 keV protons. Initially, the rate of coloration appears to be the same for two different flint glasses and for all the ions, hence proportional to the number of implanted ions. (auth)

NUCLEAR SPECTROSCOPIC INSTRUMENTAION

3799 (EGG—1183-5051) **Design, construction, and calibration of a nonfocusing neutron spectrometer.** Storey, W. (EG and G, Inc., Albuquerque, N.Mex. (USA)). Dec 1974. Contract AT(29-1)-1183. 139p. Dep. NTIS $5.45.

For Los Alamos Scientific Lab., NM.

A fourteen-channel time-resolved neutron spectrometer with associated Faraday cup has been designed and constructed for use in the field. A neutron energy range of 9.5 to 15 MeV is covered. Both instruments detect protons elastically scattered from a thin hydrogenous foil in interaction with the neutron beam, with magnetic analysis of the protons by the spectrometer. The design requirements of small size and weight and 0.6 to 0.7 MeV resolution have been met. Following a description of the instrument and of its geometry, there is a detailed presentation of the design and construction of the instrument. The section on instrument performance is concerned with the comparison between predicted performance based upon computation, in which the magnet is of primary interest, and upon measured performance based upon a calibration experiment, which is given a general description in Appendix A. Software used mainly for signal prediction and unfolding, for both the neutron spectrometer and Faraday cup, is described. (WHK)

HIGH ENERGY PHYSICS INSTRUMENTATION

3800 **Transition radiation from lithium foils.** Yuan, L.C.L.; Alley, P.W.; Bamberger, A.; Dell, G.F.; Uto, H. (Brookhaven National Lab., Upton, N.Y. (USA)). *Nucl. Instrum. Methods;* 127: No. 1, 17-20(15 Jul 1975).

The yield of transition radiation is expected to be higher for a low-Z material because of low absorption. Yields of transition radiation from lithium foils have been measured using multiwire proportional chambers and using a thin NaI counter in a beam of electrons and pions from 0.5 to 3.5 GeV/c. The transition radiator consisted of 1000 foils of 2 mil lithium spaced at 20 mils. Results from a lithium radiator are compared with those of Mylar-foil radiators, and the advantages of lithium radiators in applications are discussed. (auth)

RADIOMETRIC INSTRUMENTS

3801 (BDX—613-1284) **Evaluation of the x-ray fluorescence method of precious metal plating thickness measurements. Technological spinoff report.** Carson, J.S.; Hearn, N.K.; Pettie, C.B. (Bendix Corp., Kansas City, Mo. (USA)). Sep 1975. Contract AT(29-1)-613. 41p. Dep. NTIS $5.00.

It is shown that gold and silver plating thickness measurements made using an x-ray spectrograph could be closely correlated with thicknesses measured from sectional samples. Good correlations were also shown for single overlays of gold over silver when each layer was less than 0.0003 inch thick. (auth)

RADIATION EFFECTS ON INSTRUMENT COMPONENTS, INSTRUMENTS, OR ELECTRONIC SYSTEMS

3802 (SAND—75-5731) **CMOS optimization for radiation hardness.** Derbenwick, G.F.; Fossum, J.G. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 4p. (CONF-751206—1). Dep. NTIS $4.50.

From IEEE international electron devices meeting; Washington, District of Columbia, USA (1 Dec 1975).

Several approaches to the attainment of radiation-hardened MOS circuits have been investigated in the last few years. These have included implanting the SiO_2 gate insulator with aluminum, using chrome-aluminum layered gate metallization, using Al_2O_3 as the gate insulator, and optimizing the MOS fabrication process. Earlier process optimization studies were restricted primarily to p-channel devices operating with negative gate biases. Since knowledge of the hardness dependence upon processing and design parameters is essential in producing hardened integrated circuits, a comprehensive investigation of the effects of both process and design optimization on radiation-hardened CMOS integrated circuits was undertaken. The goals are to define and establish a radiation-hardened processing sequence for CMOS integrated circuits and to formulate quantitative relationships between process and design parameters and the radiation hardness. Using these equations, the basic CMOS design can then be optimized for radiation hardness and some understanding of the basic physics responsible for the radiation damage can be gained. Results are presented. (WHK)

3803 (UCID—16945) **Final report for EMP instrumentation project DNA IACRO 75-815: magnetic thin film sensors.** Hsieh, E.J.; Miller, D.E.; Vindelov, K.E.; Brown, T.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. Contract W-7405-Eng-48. 26p. Dep. NTIS $5.00.

The magnetic thin film current sensor/recorder is a passive device which responds to the peak current and pulse shape of a transient event. The transient current information becomes a permanent record on the film. The thin film device is small, low mass and reusable. It has been proven to be fast (less than 1/2 nanosecond response), radiation hard and applicable to peak current measurement of both CW and pulsed signals. The sensors were initially developed at LLL for pulse-energy measurement on exploding wires. Later the Defense Nuclear Agency sponsored the present project to develop the magnetic thin film devices as EMP diagnostic tools. The Air Force Weapons Lab supported the work to test the field capabilities of the thin film devices at ARES test facility, Kirtland AFB. Sandia Lab is now using a new version of the thin film sensors to monitor the transient current induced by intense radiation in their hybrid microcircuits. Also, a field test has been planned with Naval Electronics Laboratory Center where the thin film sensors are to be used to measure peak CW current caused by rf radiation. Research results are summarized. (WHK)

3804 (UCRL—76590) **Attributes of system testing which promote cost-effectiveness.** Martin, L.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Oct 1975. Contract W-7405-Eng-48. 12p. (CONF-750988—1). Dep. NTIS $4.50.

From DNA EMP seminar on system level testing; Menlo Park, California, USA (9 Sep 1975).

A brief overview of conventional EMP testing activity examines attributes of overall systems tests which promote cost-effectiveness. The general framework represents an EMP-oriented systems test as a portion of a planned program to design, produce, and field system elements. As such, all so-called system tests should play appropriate cost-effective roles in this program, and the objective here is to disclose such roles. The intrinsic worth of such tests depends not only upon placing proper values on the outcomes, but also upon the possible eventual consequences of not doing tests. A relative worth measure is required. Attributes of EMP system testing over the range of potential activity which encompasses research and development, production, field handling, verification, evaluation, and others are reviewed and examined. Thus, the relative worth, in a cost-effective sense, is provided by relating such attributes to the overall program objectives so that values can be placed on the outcomes for tradeoff purposes. (auth)

MISCELLANEOUS INSTRUMENTS

3805 (AERE-M—2728) **New 2000 series read-out system.** Reid, H.J. (UKAEA Research Group, Harwell. Atomic Energy Research Establishment). Jun 1975. 15p. Dep. NTIS (US Sales Only) $4.00. UK pounds1.00.

A new system is described for reading the data from 2000 Series scalers which may then be printed or transferred to punched tape. By employing 6000 Series modules in a 2000 series adaptor frame and by the use of a rear patching system, a number of options are available to the user. This system largely supersedes the Read-out Controller, 2140. (auth)

3806 (CRN-CNPA—75-11) **Time-of-flight mass spectrometers with particle guide.** Igersheim, R.; Abbe, J.Ch.; Paulus, J.M. (Centre National de la Recherche Scientifique, 67 - Strasbourg (France). Centre de Recherches Nucleaires). 1973. 19p. (In French). Dep. NTIS (US Sales Only) $4.50.

Two time of flight mass spectrometers have been designed. The first one consists of an arrangement of a pulsed ion source, an electrostatic particle guide and a detector; an ion reflector was added in the second aparatus. The supply of a particle guide appears to be particularly efficient in the second case for the analysis of low energy beams. The higher the initial kinetic energy of the ions, the more important is the corresponding increase in sensitivity. (auth)

3807 (EUR—5378e) **LAM-16: a 16 channel low-level amplifier and multiplexer.** Mol, M.J.; Kleih, R. (Commission of the European Communities, Ispra (Italy). Joint Research Centre). 1975. 51p. Dep. NTIS (US Sales Only) $5.00.

A self-contained low-level amplifier and multiplexer is described, which is based on low-cost special purpose plug-in amplifiers. These amplifiers were designed to operate on low-level signals from sensors with low source resistances. The multiplexer switching rate of up to 100 kHz allows the multiplexing of a large number of signals on a single wide band recording or transmission channel. (auth)

3808 (HMI-B—176) **CAMAC interface for parallel transfer of data and control of multichannel analyzer.** Becker, H.; Lengauer, C. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F.R. Germany). Bereich Datenverarbeitung und Elektronik). Jul 1975. 33p. (In German). Dep. NTIS (US Sales Only) $5.00.

A data link between Nuclear Data System Analyzers Type 2200/2201 and a computer by means of a CAMAC interface, manufactured by Packard Instrument Company, are described. The Multichannel Analyzer (MCA)-Interface is commercially available and requires only simple modifications for interfacing various analyzers. The specifications of the CAMAC-Interface are discussed, and the signals for control of the Nuclear Data System Analyzers 2200/2201 are described. The computer controls all Multichannel Analyzer functions, and the corresponding timing-signals are explained. Furthermore the functions of the essential front-panel controls of the Master Control- and Read-IN/OUT Display units are given. The tabular presentation of the control signals of the System Analyzer and the CAMAC interface shows the required modifications at the Interface. Also the special cables for interconnections are described. The command structure of the CAMAC interface is explained, and finally a program example for a fully automatic measuring sequence including data storage with a PDP 11/20 computer is given. (auth)

3809 (INIS-mf—1720) **A new noise discriminator for magnetic resonance.** Matvienko, B. (Sao Paulo Univ., Sao Carlos (Brazil). Instituto de Fisica e Quimica). 1973. 9p. Dep. NTIS (US Sales Only) $4.50.

From 25. annual meeting of the Brazilian society for the advancement of science; Rio de Janeiro, Brazil (8 Jul 1973).

A detection technique for microwave (MW) electron spin resonance is described involving a restricted number of well-defined frequencies in the initial transmission of the resonance signal, through recourse to Fourier analysis. Consequently a reduction of noise better than in conventional phase sensitive detection techniques is possible, with the added advantage of permitting the use of a lower MW power level; this at the expense of knowing beforehand the response line position. (auth)

3810 (JINR—P9-9143) **Automatic processing of the time characteristics of the waveform repeating processes using digital computer.** Denisov, Yu.N.; Lyubenko, A.N.; Chihak, M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1975. 14p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

A method is described that allows automatic processing of the waveform repeating processes in a wide amplitude-time range using a sampling oscilloscope and a digital computer. A system with the OSA-601 type oscilloscope and M-6000 type digital computer has been considered. Examples are given when this system has been used. (auth)

3811 (JINR—P10-9056) **CAMAC system organization for a readout from various groups of modules.** Zhuravlev, N.I.; Petrov, A.G.; Sidorov, V.I.; Sinaev, A.N.; Churin, I. N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A CAMAC system for a readout from various groups of modules is described. The system is based on a read-only controller operating in the address scan mode and a special LAM-grader. According to arriving L signals and their patching in the LAM-grader, signals for the following operations can be generated: a readout in the address scan mode a block transfer from one address disabling the readout from groups of stations, and ending the readout: The system is very flexible and may consist of both one and several crates. (auth)

3812 (JINR—P13-8890) **Time-to-digital converter of integrated circuits.** Valuev, Yu.M.; Grebenyuk, V.M.; Zinov, V.G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

A digitron of start-stop type designed by using integrated circuits is described. A distinction of this device consists in the presence of a register which digitally sets the duration of a maximal measured time range, and a register of auxiliary information. The maximum frequency of the series generator is 170 MHz. The maximum channel number is 1020. (auth)

3813 (KFK-PDV—46) **Methods and means contributing to the guide lines for central control stations.** Koehler, G.; May, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Jun 1975. 48p. Dep. NTIS (US Sales Only) $5.00.

All instrumentation for plant process control is centralized in control stations. The design of the control stations where the operator supervises the automations, depends on the application and the local conditions of the process. A survey on the physical design of control stations is presented. This report refers to ergonomical principles and gives a short glimpse on control technology, the present equipment and display devices. The possibilities of process analysis with existing control station concepts and the use of planning aids for the layout are described in detail. Hereafter follows an explicit representation of the possibilities of realization showing the trend of development by an example. The following explanations are the contribution to the guide lines of control stations. (auth)

3814 (MHSMP—75-24M) **Computer microdensitometer (drum scanner) system. Period covered: April—June 1975.** Black, L.W. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 2p. Dep. NTIS $4.50.

The software developed for the film reading system is general in nature. All subroutines for operation of the drum scanner are transferable to any applications program. Once hardware problems were resolved, this software proved to be very reliable. Routines for film comparisons can be used for any film that can be put on the scanner. Films with numerous density thresholds present a problem because of alignment inadequacies. A routine for reading and writing film densities is also available and is a useful tool for testing application programs and obtaining quantitative information for special studies. (WHK)

3815 (ORNL-TM—5157) **Versatile particle size analyzer.** Goldberg, G.; Costanzo, D.A. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 27p. Dep. NTIS $4.00.

A particle size analyzer has been developed which employs the Coulter technique for the measurement. The analyzer consists of a Coulter metering assembly, constant current supply, pulse height analyzer, and a data-handling module. The Coulter technique is a method of determining the number and size of particles suspended in an electrolyte by causing them to pass through a small orifice on either side of which an electrode is immersed. The changes in resistance as particles pass through the orifice generate voltage pulses whose amplitudes are proportional to the volumes of the particles. The pulses are amplified, sized, and counted, and from the derived data the size distribution of the suspended phase may be determined. Analysis may be carried out rapidly and with good reproducibility. (auth)

3816 (SAND—-75-8261) **Optical technique for strain measurement of material specimens at elevated temperatures.** Thompson, R.A.; Jorgenson, W.E.; Callabresi, M.L. (Sandia Labs., Livermore, Calif. (USA)). Sep 1975. Contract AT(29-1)-789. 23p. Dep. NTIS $4.50.

An optical technique has been developed for the measurement of strain in material specimens using a laser light source and an optical extensometer. This technique has been used up to temperatures of 2200°C with the aid of special optical targets attached to the specimen. Operational procedures and experimental data from room and elevated temperature tests are presented. (auth)

3817 (UCRL—77446) **Mass spectrometer data system at LLL.** Friesen, R.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Oct 1975. 4p. (CONF-751128—1). Dep. NTIS $4.50.

From Plutonium sample exchange meeting; Miamisburg, Ohio, USA (18 Nov 1975).

The data systems on the three mass spectrometers at LLL are computer-controlled, pulse-counting systems synchronized to a repeatedly-swept magnetic field. The data are accumulated in the memory of the computer or in a Nuclear Data ND 180 in a multi-scaler mode of operation. This mode of sweeping allows a continuous check of the background stability and makes tune-up easier. But the main benefit is a reduction in the required ion emission rate stability. By the use of standards to set the system dead time, we have been able to utilize the sensitivity of a pulse counting system without the expense of exotic equipment. (auth)

3818 (Y—2002) **System for evaluating the deformation of various materials under compressive loads.** Gallman, R.A. (Oak Ridge Y-12 Plant, Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 14p. Dep. NTIS $4.00.

A test system has been developed in two versions which can determine the deformation of various materials under selectable, uniaxial, compressive loads. The field model is an inexpensive, rugged, easily operated instrument intended for production use; whereas, the instrumented model is an accurate instrument, with analog and digital outputs, intended for use as a certification tool. (auth)

3819 (UCRL-Trans—10925) **First-order aberrations of asymmetric catoptric systems: application to the total-reflection x-ray microscope.** Montel, M. Translated from *Opt. Acta;* 1: No. 3, 117-126(Dec 1954). 26p. Dep. NTIS $5.00.

In this study, devoted to asymmetric systems with a small linear aperture, it was attempted to correct the main aberration present, astigmatism, by concentrating more particularly on simple systems consisting of two mirrors. For this purpose, geometric and

algebraic conditions were established that make it possible to solve the problem of correction for astigmatism on the axis and in the field. A relationship between the inclinations of the object and image planes was derived. A study of the magnifications is described by reporting some special cases. (auth)

3820 (ORNL-tr—2924) **SMORN-1: thermoelectrically generated noise in sheathed thermocouples and in other low level instrumentation cables.** Mathieu, F.; Meier, R.; Soenen, M.; Delcon, M.; Nysten, C. (Centre d'Etude de l'Energie Nucleaire, Mol (Belgium)). 1974. Translated by M. Gerrard, H.H. Hubbell, and R.L. Shepard from a French report. (CONF-741065—4). 49p. Dep. NTIS $5.00.

From EACRP specialist meeting on reactor noise from critical facilities to power plants; Rome, Italy (21 Oct 1974).

Starting from the fact that thermoelectric emfs of thermocouples are generated in the thermal gradients and not at the hot junction, it is shown how thermoelectric heterogeneity in conjunction with natural and forced convection phenomena gives rise to unwanted noise called: "thermoelectric noise" in the technological sense. A distinction is made between four different types of noise—i.e. uncorrelated noise, correlated noise, spectral noise and thermoelectric noise in the physical sense—each of which has its own characteristics. The experimental results presented reveal that noise amplitudes may be quite embarrassing when dealing with problems of quantitative signal fluctuation analysis. It is however emphasized that thermoelectric noise may also convey useful information which, without noise, might be lost. (auth)

3821 **Digital interface for field-regulated magnets.** Fukushima, E.; Armstrong, D.E. (Los Alamos Scientific Lab., NM). *Chem. Instrum.*; **6**: No. 2, 173-178(1975).

A scheme for modifying a Varian Fieldial Mark II magnetic field regulator so that it may by controlled by a NOVA 1200 computer is described. The Fieldial changes the field intensity in triangular or sawtooth fashion for discretely selectable field ranges and sweep times. (WHK)

3822 **Simple Raman cell and furnace usable at temperatures higher than 1000° for corrosive melts.** Gilbert, B. (Univ. of Tennessee, Knoxville); Mamantov, G.; Begun, G.M. *Appl. Spectrosc.*; **29**: No. 3, 276-278(1975).

The design of a sample container for obtaining Raman spectra of corrosive melts is presented. The cell has been used to obtain the Raman spectra of mixtures of AlF_3 and different alkali fluorides between 700 and 900°C and to reinvestigate the spectrum of molten cryolite at 1015°C. (WHK)

3823 **Improved electron microprobe scanning images.** McCoy, D.D.; Gutmacher, R.G. (Univ. of California, Livermore). *Rev. Sci. Instrum.*; **46**: No. 4, 460-463(Apr 1975).

The count-rate discriminator, CoRaD, was developed for use with the x-ray microprobe and scanning electron microscope. It is a digital device that facilitates the production of background-free x-ray scanning images. It has been used to great advantage in analyzing multiphase specimens containing the same elements in different proportions. CoRaD permits the selective display of any one phase exclusive of the others. When CoRaD is interfaced to three scalers, the volume fraction and mean particle size of selected phases can be determined. (auth)

3824 **TV-type multichannel detectors.** Talmi, Y. (Oak Ridge National Lab., TN). *Anal. Chem.*; **47**: 697A-705A(Jun 1975).

A review of TV-type multichannel detectors is given. A description of various types of image intensifiers, rapid electron scanners, and signal-generating image tubes is given. A Glossary of terms is appended. (WHK)

3825 **Applicability of TV-type multichannel detectors to spectroscopy.** Talmi, Y. (Oak Ridge National Lab., TN). *Anal. Chem.*; **47**: 658A-665A(Jun 1975).

State-of-the-art TV-type multichannel detectors have already broadened the scope of spectroscopy. Nevertheless, to become universally applicable in the UV-VIS regime, their format and number of pixels should be enlarged (1000 x 1000 pixels), their sensitivity improved to provide a single photon capability, their UV response extended to the vacuum UV, and their dynamic range extended to 10^3--10^5. There are very few detectors whose spectroscopic performance approaches these requirements, and they are very complex and expensive. The technology required to manufacture solid-state imagers with such a performance is already available, but commercial production is slow because of lack of interest and financial support. Either linear or area imagers should become useful for atomic spectroscopy studies in which a spectral coverage of 200 to 800 nm and resolution of 0.02 to 0.05 nm are required. This will be accomplished by using a 15,000-pixel linear array or 500 X 500 area array coupled to a low-resolution echelle spectrograph. This last approach will be further simplified when a CID with x-y random access capability becomes available. Finally, the construction of intensified solid-state imagers or the commercial availability of low-noise imagers will allow for low-light level measurements as required in atomic and molecular fluorescence. (auth)

3826 **Up/down frequency shifter for optical heterodyne interferometry.** Sommargren, G.E. (Univ. of California, Livermore). *J. Opt. Soc. Am.*; **65**: No. 8, 960-961(Aug 1975).

A technique is being presented by which two waves of different frequency can be generated from a linearly polarized, quasimonochromatic source and subsequently used for heterodyne interferometry. In practice, mechanical rotation of a half-wave plate limits the frequency shift to about 2 kHz. When greater frequency shifts are desired, it is necessary to simulate the rotating half-wave plate electro-optically. (WHK)

3827 **Sub-nanosecond metal-oxide-semiconductor pressure switch for the terapascal range.** Kalibjian, R.; Brier, R.L. (Univ. of California, Livermore). *Rev. Sci. Instrum.*; **46**: No. 9, 1241-1243(Sep 1975).

A solid-state sensor has been developed to give a signal risetime of 1 nsec in the TPa pressure range. For applications requiring a high signal-to-noise ratio, the sensor is operated reliably in the switch mode with a 50-V bias voltage. The pressure sensor can also be operated in the shock-induced polarization mode giving 2-nsec FWHM signals with 0.6-V amplitude. (auth)

3828 **Metal-film high-frequency ultrasonic transducer.** Chimenti, D.E. (Argonne National Lab., IL); Maxfield, B.W. *J. Appl. Phys.*; **46**: No. 9, 4073-4075(Sep 1975).

It is shown that moderately pure metal films deposited on an insulating substrate can act as an efficient transducer for ultrasound in the 100 to 1000-MHz range. Electromechanical conversion takes place in the skin depth of the film by direct action of the electric field on the ions. Displacements comparable to those achievable using bonded-quartz resonant-plate transducers can be obtained between 100 and 1000 MHz. The main advantages of this method of generating ultrasound are its large inherent bandwidth and the absence of troublesome mechanical bonds at high frequencies. (auth)

3829 (BNWL-tr—157) **Ultrasonic measuring technique in sodium systems.** Rohrbacher, H.A.; Bartholomay, R. (Kernforschungszentrum Karlsruhe (F.R. Germany). Inst. fuer Reaktorentwicklung). Oct 1975. Translation of KFK—2116. 78p. Dep. NTIS $6.00.

Different versions of acoustic sensors are being investigated and tested in a water model with a view to novel ultrasonic detection methods to be applied in systems under sodium. The advantages and drawbacks of acoustic wave guides are discussed and compared with the properties of so-called direct sensors, taking into account the high temperatures in the environment. A new high-temperature piezoelectric material as well as the technology of direct sensor manufacturing are presented. The results of various methods of piezoelectric crystal bonding with the stainless steel diaphragms are described and explained by means of oscillograms. Finally, estimates are given for an ultrasonic sweep arm with respect to the extent of errors of the detected objects and the sonic beam distortions in detection areas with sodium layers of different temperatures. (auth)

3830 **Temperature measurement errors with type K (Chromel vs Alumel) thermocouples due to short-ranged ordering in Chromel.** Kollie, T.G.; Horton, J.L.; Carr, K.R.; Herskovitz, M.B.; Mossman, C.A. (Oak Ridge National Lab., TN). *Rev. Sci. Instrum.*; **46**: No. 11, 1447-1461(Nov 1975).

After annealed, type K (Chromel vs Alumel) thermocouples were heated above 200°C, their temperature measurements were in error up to 1.3 percent, as determined by comparison calibrations to working standard 90 percent Pt--10 percent Rh/Pt thermocouples or platinum resistance thermometers. Reannealing the type K thermocouples removed the errors. The errors were due to changes in the thermal emf vs temperature relationship of the type K thermocouples, which from previous work of others can be attributed to short-ranged ordering of the Chromel thermoelements. Reannealing the thermocouples removed the errors because the order--disorder transformation is reversible; that is, short-ranged ordering of the Ni and Cr atoms of the Chromel alloy occurs between 200° and 600°C, and disordering occurs above 600°C. The traveling gradient method was used to determine the effects of heat treatment on the thermal emf of type K thermocouples, to investigate the kinetics of ordering of Chromel, and to determine the amount of order produced by heat treatments. Though the order--disorder transformation could not be stopped, results demonstrate that there exists an optimum amount of order in the Chromel ther-

moelement to yield a repeatable thermal emf vs temperature relationship for a type K thermocouple in a specific application. When the experimental conditions of the application were controlled carefully, isothermal heat treatment to produce the optimum order in the Chromel thermoelements and calibration of the type K thermocouples prior to use essentially eliminated the temperature measurement errors due to order. The optimum amount of order depended on the application and was determined experimentally. (auth)

EXPLOSIONS AND EXPLOSIVES

3831 (UCID—16880) **Monte Carlo calculations of cumulative target survival probability in the presence of warhead fratricide.** Mendelsohn, E.; Kruger, H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1975. Contract W-7405-Eng-48. 168p. Dep. NTIS $7.60.

Survival probabilities for targets attacked by several almost simultaneously arriving warheads have been calculated using the Monte Carlo method. These probabilities are represented as a function of various applicable parameters, including warhead fratricide. The computer code used for this work is described, and the results of our calculations are discussed. (auth)

CHEMICAL

3832 (MHSMP—75-24L) **Detonation electric effect studies. Final report, April—June 1975.** Canada, C.E.; Hanes, L.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. 15p. Dep. NTIS $4.50.

A technique has been devised to determine the configuration dependent induction time for transfer of detonation from a small diameter confined donor to a large diameter unconfined acceptor via the detonation electric effect. This report explains some of the attributes and limitations of the technique and includes test data for PETN, RDX/Sylgard, and HNS explosive assemblies. (auth)

3833 (MHSMP—75-35) **Detonation electric effect studies. Final report for period April—June 1975.** Canada, C.E.; Hanes, L.D. (Mason and Hanger-Silas Mason Co., Inc., Amarillo, Tex. (USA)). 1975. Contract DA-11-173-AMC-487(A). 16p. Dep. NTIS $4.50.

For Sandia Lab., Albuquerque, NM.

A technique has been devised to determine the configuration-dependent induction time for transfer of detonation from a small diameter confined donor to a large diameter unconfined acceptor via the detonation electric effect. This report explains some of the attributes and limitations of the technique and includes test data for PETN, RDX/Sylgard, and HNS explosive assemblies. (auth)

3834 (UCID—16953) **Equation of state for pentolite.** Lee, E.L.; Walton, J.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Nov 1975. Contract W-7405-Eng-48. 10p. Dep. NTIS $4.50.

The purpose of the work reported is to carefully define the properties of PENTOLITE, especially the behavior of the detonation products, in order to carry out accurate measurements and calculations on shockwaves were carried out to verify the estimated detonation product behavior. The results are summarized as a set of Chapman-Jouguet parameters and JWL equation-of-state parameters. (auth)

3835 (UCRL—77429) **Champ code calculations of surface and subsurface explosions.** Edwards, L.L.; Hickman, R.B.; Hobson, J.K.; Michels, T.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Oct 1975. Contract W-7405-Eng-48. 3p. (CONF-751207—1). Dep. NTIS $4.50.

From SIGNUM-Ames meeting; Moffett Field, California, USA (8 Dec 1975).

The CHAMP (Coupled HEMP and Multifluid Eulerian Program) computer code package solves complex radiation diffusion and hydrodynamics problems. The structure of the code package and its applications to high-energy explosions on the ground surface and at shallow depths of burial are discussed. (auth)

3836 (UCRL-Trans—10731) **Head for a shaped-charge projectile.** Held, M.; Rosner, H.; Germahausen, R.; Sabranski, U. 21 Jul 1972. Translation of French Patent No. 2,147,621. 7p. Dep. NTIS $4.00.

The invention discloses a head for a shaped-charge projectile that has a maximum penetrating power for a minimum weight, i.e., the head for the shaped charge is such for a given caliber; one obtains the best efficiency with regard to the ratio of penetrating power to weight. (TFD)

NUCLEAR

3837 (UCRL—13662) **Transient compressible flows in porous media.** Morrison, F.A. Jr. (Illinois Univ., Urbana (USA)). Sep 1975. 88p. Dep. NTIS $6.00.

For The Regents of the Univ. of California.

Transient compressible flow in porous media was investigated analytically. The major portion of the investigation was directed toward improving and understanding of dispersion in these flows and developing rapid accurate numerical techniques for predicting the extent of dispersion. The results are of interest in the containment of underground nuclear experiments. The transient one-dimensional transport of a trace component in a gas flow is analyzed. A conservation equation accounting for the effects of convective transport, dispersive transport, and decay, is developed. This relation, as well as a relation governing the fluid flow, is used to predict trace component concentration as a function of position and time. A detailed analysis of transport associated with the isothermal flow of an ideal gas is done. Because the governing equations are nonlinear, numerical calculations are performed. The ideal gas flow is calculated using a highly stable implicit iterative procedure with an Eulerian mesh. In order to avoid problems of anomolous dispersion associated with finite difference calculation, trace component convection and dispersion are calculated using a Lagrangian mesh. Details of the Eulerian-Lagrangian numerical technique are presented. Computer codes have been developed and implemented on the Lawrence Livermore Laboratory computer system. (TFD)

3838 (UCRL—51901) **Calculational model for condensation of water vapor during an underground nuclear detonation.** Knox, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1 Oct 1975. Contract W-7405-Eng-48. 34p. Dep. NTIS $4.00.

An empirally derived mathematical model was developed to calculate the pressure and temperature history during condensation of water vapor in an underground-nuclear-explosion cavity. The condensation process is non-isothermal. Use has been made of the Clapeyron-Clausius equation as a basis for development of the model. Analytic fits to the vapor pressure and the latent heat of vaporization for saturated-water vapor, together with an estimated value for the heat-transfer coefficient, have been used to describe the phenomena. The calculated pressure-history during condensation has been determined to be exponential, with a time constant somewhat less than that observed during the cooling of the superheated steam from the explosion. The behavior of the calculated condensation-pressure compares well with the observed-pressure record (until just prior to cavity collapse) for a particular nuclear-detonation event for which data is available. (auth)

CIVIL USES

3839 (LA—6090-MS) **Pacer processing: cavity inventory relationships.** Dietz, R.J.; Gritzo, L.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-ENG-36. 16p. Dep. NTIS $4.00.

The pacer cavity and its associated primary power loop comprise a recirculating system in which materials are introduced by a series of thermonuclear explosions while debris is continuously removed by radioactive decay, sorption phenomena, and deliberate processing. Safe, reliable, and economical realization of the Pacer concept depends on the removal and control of both noxious and valuable by-products of the fusion reaction. Mathematical relationships are developed that describe the quantities of materials that are introduced into the Pacer cavity by a series of discrete events and are removed continuously by processing and decay. An iterative computer program based on these relationships is developed that allows both the total cavity inventory and the amounts of important individual species to be determined at any time during the lifetime of the cavity in order to establish the effects of the thermonuclear event, the cavity, the flow, and various processing parameters on Pacer design requirements. (auth)

3840 (PNE-RB—72) **Project Rio Blanco definition plan. Additional formation evaluation and production testing.** (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Sep 1975. 53p. (NVO—165). Dep. NTIS $5.50.

Since the multiple Rio Blanco detonation three reentry wells have been drilled for test purposes: RB-E-01 (Emplacement Well); RB-AR-2 (Alternate Reentry Well); and RB-U-4 (Formation Evaluation Well). Additional testing in all these wells is now required to resolve some remaining technical questions. A plan describing the procedures, methods, responsibilities, and scheduling of the field operations is presented. (TFD)

WEAPONRY

3841 (LA—6076-MS) **Lognormal damage function with offset circular normal target and weapon locations: mean and other moments.** Bruckner, L.A. (Los Alamos Scientific Lab., N.Mex. (USA)). Aug 1975. Contract W-7405-eng-36. 9p. Dep. NTIS $4.00.

If target location and weapon impact point have independent circular normal probability distributions, the probability density function of the distance between target and weapon impact can be determined. If a damage function is introduced as a measure of the probability of damage to a target, the expected probability of damage can then be computed. This report shows how to compute and use mean and higher moments of the probability of damage for a log-normal damage function. Moments for other damage functions can be similarly computed. (auth)

ENVIRONMENTAL SCIENCES, ATMOSPHERIC

BASIC STUDIES

3842 (LA—6111-MS) **Stratospheric chemistry computations.** Zinn, J.; Sutherland, C.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Sep 1975. Contract W-7405-eng-36. 20p. Dep. NTIS $4.00.

This report describes a one-dimensional time-dependent model of atmospheric photochemistry, eddy diffusion, and rainfall in the troposphere and stratosphere (0 to 60 km altitude). Diurnal and seasonal changes are explicitly considered for fixed values of latitude. We find that the computed seasonally averaged ozone column densities are in good agreement with observational data; however, the seasonal and latitude variations are not correctly predicted. The effects of nuclear explosions and stratospheric injections of NO/sub x/ are explored. A nuclear yield of 2700 Mt produces a computed worldwide ozone reduction of 30 percent and 1350 Mt has the same effect if confined to one hemisphere. The ozone reduction lasts about 10 years. (auth)

3843 (LA-UR—75-1988) **Heavy methanes as atmospheric tracers.** Cowan, G.A.; Ott, D.G.; Turkevich, A.; Machta, L.; Ferber, G.J.; Daly, N.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 13p. (CONF-751027—4). Dep. NTIS $4.50.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

Because methane-21($^{13}CD_4$) is essentially non-existent in nature and should undergo isotopic exchange very slowly, it is potentially a useful non-radioactive label for tracking air motions and testing transport and diffusion models on a continental scale. In a first field experiment, to demonstrate long-range detection, 84 g of methane-21 released in Idaho were detected in the atmosphere at concentrations ranging from 2 to 10 x 10^{-17} by volume at distances from the release point varying from 1500 km to almost 2500 km. The amounts of the methane-21 found at each of four stations at expected times are generally in the range calculated on the basis of a simple meteorological model. (auth)

3844 (RISO—285) **Kinetic energy spectrum of atmospheric motions in the planetary boundary layer.** Petersen, E.L. (Danish Atomic Energy Commission, Risoe. Research Establishment). Jan 1975. 103p. Dep. NTIS (US Sales Only) $8.25.

Kinetic energy spectra of the horizontal wind vector were estimated from time series measured along the Riso 123 m meteorological tower throughout ten years. Also measurements from other localities (Station Nord, Greenland, and Karlstrup, Zealand) were used. Spectra and methods are presented and discussed. Emphasis is laid on the gain in information which is achieved when the components of the wind vector are considered rather than just the wind speed. Spectral equations in the frequency domain are derived from the equations of motion. It is shown how a ratio including the Coriolis parameter, the quadrature spectrum of the components, the energy spectrum, and the frequency can be used to determine the explicit effect of the rotating of the earth on the kinetic energy spectrum. The wind structure in the bounday layer, as measured at the Riso site, and its relation to the diurnal cycle and horizontal inhomogeneities of surface temperature are investigated. The data reveal an exceptionally large turning of the wind with the height above the ground. It is shown that this feature can be given a phenomenological description by making an analogy to the thermal-wind effect. (auth)

RADIOMETRIC TECHNIQUES

3845 (ATDL—75/17, pp 227-240) **Response of lintronic dome solarimeters to varying solar radiation flux densities.** Matt, D.R.; Hutchison, B.A. Sep 1975.

In 1974 annual report.

Solar radiation was measured in a Liriodendron tulipifera forest for the past year as part of the US-IBP Eastern Deciduous Forest Biome effor at Oak Ridge, Tennessee. During our collection and analysis of these data, the calibration coefficients of Lintronic Dome Solarimeters were compared to a shelf standard Eppley precision pyranometer. Large variation from manufacturer's supplied calibration coefficients was noted at low-intensity radiation levels resulting in non-linear response. This variation is of significance since it is largest precisely in the flux density regime present within fully leafed, mature forests. An empirical relationship for each Lintronic Dome solarimeter was determined to better approximate the calibration coefficients for low-flux density levels. (auth)

CHEMICALS MONITORING AND TRANSPORT

3846 (ATDL—75/17, pp 71-89) **Relating emissions to air quality in Tennessee.** Hanna, S.R. Sep 1975.

In 1974 annual report.

Average annual emissions of suspended particles, SO_2, and CO from each of the 95 counties in Tennessee during 1970 are compared with observed air quality. Due to the location of air monitoring instruments close to large local sources, the readings of these instruments are found to be usually not representative of regional air quality. In order to adequately test regional dispersion models in Tennessee, it is necessary to install additional air monitoring stations that are not influenced by large local sources. The variations of county pollutant concentrations across the state are generally within a factor of three, while the variations of county pollutant emissions are generally over several orders of magnitude. The wind speed therefore strongly controls the day-to-day background level of air pollution in the state. (auth)

3847 (ATDL—75/17, pp 117-125) **Further comparison of urban air pollution models.** Gifford, F.A. Sep 1975.

In 1974 annual report.

Comparisons of the ATDL simple urban diffusion model with the outputs of other models and with urban pollution data were continued. Some recent results are summarized briefly. The derivation of the ATDL model is given in some detail in the reference. (auth)

3848 (ATDL—75/17, pp 185-212) **Description of the Eastern Tennessee Trajectory Experiment (ETTEX), December 1974.** Hanna, S.R.; Nappo, C.J.; Hosker, R.P.; Briggs, G.A. Sep 1975.

In 1974 annual report.

The eastern Tennessee trajectory experiment was conducted during July and August, 1974. Its primary purpose was to measure certain aspects of mesoscale transport and diffusion over rather complex terrain. The trajectories of radar-tracked tetroons were determined for several different launch times under a variety of weather conditions. These results are to be compared with trajectories computed using vertical wind profiles and surface measurements obtained concurrently over a grid of five single-theodolite pibal stations. Observed relative diffusion of tetroon pairs will be used in refining prediction techniques based on diffusion theory. In addition, the aerial and ground level SO_2 concentrations due to convective afternoon conditions were studied. Helicopter traverses of the plume from a tall stack were used to determine SO_2 distribution within the plume. Concurrent vertical profiles of eddy dissipation rate and temperature and vertical velocities induced by convection in the mixing layer were obtained with an instrumented airplane. Frequent double-theodolite pibal ascents provided vertical wind profiles. These results will be used in an effort to predict ground-level effluent concentrations in convective conditions. This report describes the overall design of the experiment and the schedule of its execution. More complete analyses will appear in subsequent reports. (auth)

3849 (ATDL—75/17, pp 214-221) **Average aerosol scale heights over Oak Ridge, Tennessee.** Culkowski, W.M.; Swisher, S.D. Sep 1975.

In 1974 annual report.

The results of 19 months of routine lidar shots are presented. The aerosol scale height is a function of both time of day and month of the year. Average scale heights correlate well ($r = 0.87$) with average daily solar radiation. (auth)

3850 (CONF-740370—, pp 47-65) **Relating emissions to air quality in Tennessee.** Hanna, S.R. (Atmospheric Turbulence and Diffusion Lab., Oak Ridge, TN). 1974.

From 4. annual industrial air pollution control conference; Knoxville, Tennessee, USA (28 Mar 1974).

In Proceedings of the fourth annual industrial air pollution control conference.

Average annual emissions of suspended particles, SO_2, and CO from each of the 95 counties in Tennessee during 1970 were compared with observed air quality. Due to the location of air monitoring instruments close to large local sources, the readings of these instruments were found to be usually not representative of regional air quality. In order to adequately test regional dispersion models in Tennessee, it is necessary to install additional air monitoring stations that are not influenced by large local sources. The variations of county pollutant concentrations across the state are generally within a factor of three, while the variations of county pollutant emissions are generally over several orders of magnitude. The wind speed therefore strongly controls the day-to-day background level of air pollution in the state. (auth)

3851 (ERDA—1217-75) **Chemist-Meteorologist Workshop, January 13—17, 1975, Ft. Lauderdale, Florida.** (Energy Research and Development Administration, Washington, D.C. (USA). Div. of Biomedical and Environmental Research). 1975. 94p. Dep. NTIS $6.50.

Separate abstracts were prepared on the four sections of this report. (CH)

3852 (ERDA—1217-75, pp 5-36) **Sulphur budgets on multi-state scales.** 1975.

In Chemist-Meteorologist Workshop, January 13—17, 1975, Ft. Lauderdale, Florida.

Problems in the assessment of atmospheric sulfur transport are discussed with emphasis on monitoring, parameterization, modelling, and the chemical and physical transformations of sulfur in well-defined plumes and in the free atmosphere into which the plume is dispersed. The measurements required to characterize the formation and decay of SO_2 and to determine sources of SO_2 are described. The SO_2 monitors now available are evaluated and recommendations are presented for the development of low-cost automated aerosol samples. (CH)

3853 (ERDA—1217-75, pp 37-50) **Role of aerosols in producing inadvertent weather and climate modification.** 1975.

In Chemist-Meteorologist Workshop, January 13—17, 1975, Ft. Lauderdale, Florida.

The impacts of man-made aerosols on weather and climate are discussed, with emphasis on urban areas. The effects of anthropogenic aerosols on alterations in closed processes, surface temperature, and rainfall with resulting effects on visibility, agriculture production, solar energy conversion, the biosphere, and global climate are considered. The need to consider the atmospheric implications in the development of energy sources is stressed. (CH)

3854 (ERDA—1217-75, pp 51-71) **Contribution of meteorologists and atmospheric chemists to epidemiological studies.** 1975.

In Chemist-Meteorologist Workshop, January 13—17, 1975, Ft. Lauderdale, Florida.

The health hazards of air pollution are discussed with emphasis on the valuable contribution that meteorologists and atmospheric chemists can make to epidemiological, clinical, and toxicological studies of the adverse effects from burning sulfur-bearing fossil fuels. Recommendations for research programs on the effects of SO_2 levels, smoke, or suspended particulates on mortality are included. (CH)

3855 (ERDA—1217-75, pp 73-89) **Use of high sulfur fuels.** 1975.

In Chemist-Meteorologist Workshop, January 13—17, 1975, Ft. Lauderdale, Florida.

Air quality standards in the USA in 1975 are discussed in relation to sulfur content of coal reserves and the combustion of fossil fuels. Control strategies that can be applied within the next 10 years to assure an adequate energy supply while conforming to whatever air quality standards that are required are considered. Emphasis is placed on standards for SO_2 and particulate sulfur in surface air. (CH)

3856 (EUR—5135d) **Environment and quality of life. Instruments and measurement techniques for the establishment of air pollution.** Jost, D. (Commission of the European Communities, Luxembourg). Sep 1974. 106p. (In German). Dep. NTIS (US Sales Only) $8.50. EUR BF 125.-.

This study provides a summary of the air pollution measuring methods used in the industrialized countries. Emphasis is given to methods which are in use in the member countries of European Community. The measuring methods are grouped according to the relevant gaseous and particulate air pollutants. Within each group the discontinuous methods are handled first. For each continuous indicating method the prices of the most important instruments are indicated. Literature references are far from complete but permit the application of the relevant methods. Broadly applied methods are available for CO, CO_2, SO_2, NO_2, O_3, NH_3, TSP, Pb, dust fall. Nevertheless almost no indications concerning the comparability of these methods are available. For CO and CO_2 the Non Dispersive Infrared Spectroscopy is used in routine and as reference. SO_2 is measured discontinuously by "TCM" or "Acidity" and continuously colorimetric, coulometric,conductometric or by flame fotometry. Nitrogenoxides are measured discontinuously by the Saltzman method and continuously whether coulometric or by chemiluminescence. O_3 is commonly measured by the KJ method or by chemiluminescence. For NH_3 an indophenolblue method is applied in most countries. TSP are measured by light reflectance, light absorption or β absorption. The lead content of aerosols is analysed most times by X-ray fluorescence or Atomic Absorption Spectrometry and relatively seldom by a wet chemical colorimetric method. Dust fall is sampled in special receptors which are standardised in each country. For almost all the methods noted in this study the calibration still gives problems. At the end of each chapter describing the measuring methods a table summarises data on the methods. At the end of the study a condensed table shows the most important methods and characteristic data. (auth)

3857 (LBL—3818) **Environmental measurements of air and water quality.** Mack, D.A. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). May 1975. Contract W-7405-Eng-48. 12p. (CONF-750521—5). Dep. NTIS $4.00.

From ISPRA symposium; Stresa, Italy (20 May 1975).

New energy conversion processes may aggravate the problem of maintaining a high quality of our environment. Central to the concept of maintaining high quality is the need to measure those parameters which contribute to environmental degradation. There is thus an obvious requirement for use of accurate and effective instrumentation. The report lists the most prevalent air and water pollutants, note typical levels encountered in background and urban concentrations and examine the methods presently employed in their analysis. (auth)

3858 (UCRL—52000-75-8, pp 9-10) **Environment and safety. Livermore regional air quality (LIRAQ) models: tracking pollutant concentrations.** Aug 1975.

In Lawrence Livermore Laboratory energy and technology review.

Two regional air quality computer simulations were developed for pollution control studies. Using local topography, meteorology, and pollutant-source inventory as input data, these simulations, called Livermore Regional Air Quality (LIRAQ) models, can calculate the time and space variation of pollutant concentrations in each of many fixed-grid cells. The San Fransisco Bay Area Air Pollution Control District will soon implement the models for various studies. (auth)

3859 (JPRS—65836) **Combined action on the human organism of a mixture of the major components of automobile exhaust gases (carbon monoxide, nitrogen dioxide, formaldehyde, and hexane).** Fel'dman, Yu.G. Translated from *Gig. Sanit.*; No. 10, 7-10(1974). 7p. Dep. NTIS (US Sales Only) $4.50.

The report contains a study of the effects on the human organism of a combination of a mixture of the major components of automobile exhaust gases, including carbon monoxide, nitrogen dioxide, formaldehyde, and hexane. Standards for the concentration of such mixtures in the air are included. (CH)

3860 **Current methods in air quality measurements and monitoring.** Hollowell, C.D.; McLaughlin, R.D.; Stokes, J.A. (Univ. of California, Berkeley). *IEEE Trans. Nucl. Sci.*; **NS-22**: No. 2, 835-848(Apr 1975).

Current methods for air quality measurements and monitoring are given. A review of the current national air quality and emission standards is given. Various types of monitoring instruments are discussed. (PCS)

3861 **Carcinogenic and cocarcinogenic effects of inhaled synthetic smog and ferric oxide particles.** Nettesheim, P. (Oak Ridge National Lab., TN); Creasia, D.A.; Mitchell, T.J. **55**: No. 1, 159-169(Jul 1975).

The carcinogenic and cocarcinogenic activity of synthetic smog, ferric oxide (Fe_2O_3) dust, and a mixture of the two air contaminants was determined in a long-term inhalation study with Syrian hamsters. Inhaled Fe_2O_3 particles definitely enhanced diethylnitrosamine tumorigenicity in the peripheral lung. Synthetic smog did not. When tested at a concentration of 40 ppM methane equivalents or 40 mg/m^3, respectively, neither air pollutant by itself appeared carcinogenic. Fe_2O_3 caused pulmonary fibrosis and synthetic smog caused alveolar bronchiolization in many of the exposed animals. (auth)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

3862 (CONF-751043—1) **Data base of the environmental aspects of the transuranics.** Pfuderer, H. (Oak Ridge National Lab., Tenn. (USA)). 1975. Contract W-7405-eng-26. 7p. Dep. NTIS $4.00.

From Workshop on the biological effects and toxicity of Pu 239 and Ra 226; Sun Valley, Idaho, USA (6 Oct 1975).

Indexed and abstracted references to the environmental aspects of the transuranium elements are entered into and are retrievable from a dynamic, computerized information file (or data base) that is easily modified to reflect changing research needs. The information is distilled from the documents with the specific needs of the researcher in mind, such as numeric results, new methods, or instrumentation. The major areas of evaluation are: biological and medical studies on the effects of the transuranics, particularly as these elements relate to health considerations in man; biological and ecological availability, turnover, and food chain dynamics; analysis of environmental materials; environmental transport mechanisms, including resuspension; waste disposal as related to environmental concerns; monitoring; and regulations and standards for environmental levels. Annotated references are indexed to allow easy access for retrieving references to documents of interest to the user. The goal is to furnish the users all the references related to their specific query and few that are unrelated. This is done by liberal use of subject categories and keyterms. The studies on man and animals are divided into the subject categories of medical and biological aspects. Those aspects that are considered important when the document is analyzed are tabulated. These data are sought for in the article, included in the abstracts, and indexed with keyterms. This checklist is one of the ways the Data Base on the Environmental Aspects of the Transuranics strives to give users a reference to every paper in their subject area. (CH)

3863 (LA-UR—75-1915) **Elements of quality assurance in environmental surveillance.** Johnson, L.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 13p. (CONF-750967—17). Dep. NTIS $4.50.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Qualities of an environmental surveillance program requiring control or assurance are reviewed. Requirements of accuracy, reproducibility, sensitivity, acceptability, and time and cost effectiveness are qualities discussed. The controls applicable to sample collection, handling, chemical analysis, measurement and data presentation are identified and discussed as they pertain to environmental monitoring. Quality assurance program recommendations for developing and reporting environmental surveillance data are provided. (auth)

3864 (PEL—246) **Environmental radioactivity at the National Nuclear Research Centre, Pelindaba. Report for the year 1974.** van As, D.; Vleggaar, C.M. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Jul 1975. 19p. Dep. NTIS (US Sales Only) $4.50.

Results are reported from an environmental survey in the vicinity of the National Nuclear Research Center (NNRC) at Pelindaba, Republic of South Africa during 1970 through 1974. Emphasis was placed on monitoring the critical paths of exposure of the general public. The analytical method for ^{131}I in milk was improved to give a lower detection limit, and the gamma background survey now also includes a more specific measurement for ^{131}I. Results of determinations of both gross radioactivity and individual nuclides in samples of fish and water (which are critical materials for liquid effluent releases) from the Hartbeespoort Dam and from the Crocodile River, are given and discussed. Results of gamma-spectrometric ^{131}I and ^{90}Sr analyses of milk, the critical material for releases to the atmosphere, are presented. Results are given of regular investigations of the composition of effluent releases which were well below the permissible levels. Levels of deposited and airborne activity from nuclear bomb tests are reported. No environmental radioactivity resulting from NNRC releases could be detected above the fallout levels. (auth)

3865 (UCCND-CSD-INF—64) **Statistical analysis of environmental data.** Beauchamp, J.J.; Bowman, K.O.; Miller, F.L. Jr. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 29p. Dep. NTIS $4.00.

This report summarizes the analyses of data obtained by the Radiological Hygiene Branch of the Tennessee Valley Authority from samples taken around the Browns Ferry Nuclear Plant located in Northern Alabama. The data collection was begun in 1968 and a wide variety of types of samples have been gathered on a regular basis. The statistical analysis of environmental data involving very low-levels of radioactivity is discussed. Applications of computer calculations for data processing are described. (CH)

3866 (UCRL—52000-75-8, pp 12-16) **Environment and safety. ARAC: real-time prediction of hazards due to radioactive releases.** Aug 1975.

In Lawrence Livermore Laboratory energy and technology review.

The Atomospheric Release Advisory Capability (ARAC) is an ERDA-sponsored service designed to provide nuclear facilities with real-time predictions of the health hazards that might result from a release of radionuclides or other toxic materials. A two-laboratory feasibility study has proved the concept. LLL has built and is now operating a prototype ARAC component. ERDA plans to implement ARAC service at six of its nuclear facilities during the next three years. (auth)

3867 (ZJE—166) **METEO-1: a programme for calculations of atmospheric dispersion of activities from nuclear power reactors.** Veverka, O.; Valenta, V.; Vlachovskii, K. (Skoda, Plzen (Czechoslovakia)). 1975. 30p. Dep. NTIS (US Sales Only) $4.50.

The atmospheric transport and turbulent diffusion of radioactive gaseous wastes from a nuclear power plant under various meteorological conditions were calculated for normal reactor operating conditions and reactor accidents. Formulae used in the calculations for two stack heights are included. (CH)

3868 (ZJE—167) **Some comments on the problem of the atmospheric transport of radioactivities released from a ventilation stack or from a leaky reactor building.** Valenta, V.; Vlachovskii, K.; Veverka, O. (Skoda, Plzen (Czechoslovakia)). 1975. 9p. Dep. NTIS (US Sales Only) $4.00.

A formula is presented for use in calculating the atmospheric transport of radioactive gases released to the environment from the stack of a nuclear power plant or following leakage from the building. Variables considered are the stack height and meteorological conditions. (CH)

3869 (ERDA-tr—65) **Hot aerosol particles associated with industrial atomic energy.** Bykhovskii, A.V.; Zaraev, O.M. Oct 1975. Translation of Goryachie aerozol'nye chastitsy pri tekhnicheskom ispol'zovanii atomnoy energii, Atomizdat, Moscow, 1 February 1974. 209p. Dep. NTIS $7.60.

The broad range of problems associated with radiation safety in the case of contamination of the atmosphere by highly active aerosol particles is discussed. The modern concepts of radiation danger of aerosols, features of its assessment and monitoring, connected with the presence of radioactive particles in the composition of radioactive aerosol systems are presented. Also examined are the basic mechanisms by which radioactive aerosol particles are formed during the industrial utilization of atomic energy, particularly in nuclear reactors and large gamma-machines, and also during the recycling and processing of nuclear fuel. (554 references). (auth)

THERMAL EFFLUENTS MONITORING AND TRANSPORT

3870 (ATDL—75/17, pp 135-141) **Diurnal variation of vertical thermal structure in a pine plantation.** Hosker, R.P. Jr.; Nappo, C.J. Jr.; Hanna, S.R. Sep 1975.

In 1974 annual report.

Initial observations of the diurnal variation of the vertical thermal structure of a loblolly pine plantation are presented. Results obtained in other forests are qualitatively confirmed. On a clear day a very unstable temperature gradient occurs above the trees, while a strong inversion (~ 8°C) develops below the crowns. At night the sub-crown region becomes weakly unstable, but the atmospheric layer above the trees is then stable. On a rainy day, the strength of the temperature inversion beneath the tree crowns is less than 1°C. The position of the daytime temperature maximum in the tree-tops responds to the solar elevation, eventually descending about 2 m to the region of maximum foliage density as the sun's rays penetrate deeper into the tree crowns. (auth)

ENVIRONMENTAL SCIENCES, TERRESTRIAL

BASIC STUDIES

3871 (COO—3426-13) **Experimental ecology of selected vertebrate species. Progress report, August 1, 1974—July 31, 1975.** Hartman, R.T. (Pittsburgh Univ., Pa. (USA)). 1975. Contract AT(11-1)-3426. 31p. Dep. NTIS $5.00.

This bibliography contains some 350 references to the literature on mast production by U.S. forest trees. (CH)

3872 **Vegetation of the Santa Catalina Mountains, Arizona. V. Biomass, production, and diversity along the elevation gradient.** Whittaker, R.H. (Cornell Univ., Ithaca, NY); Niering, W.A. *Ecology;* **56**: No. 4, 771-790(Sum 1975).

Measurements were taken in 15 communities along the elevation gradient from fir forest at high elevations, through pine forest, woodlands, and desert grassland, to deserts at low elevations in the Santa Catalina Mountains, Arizona, and in a Cercocarpus shrubland on limestone. Eight small-tree and shrub species of woodlands and deserts were subjected to dimension analysis by the Brookhaven system. Aboveground biomass decreased along the elevation gradient from 36-79 dry kg/m² in fir and Douglas-fir forest to 0.26-0.43 kg/m² in the desert grassland and two desert samples. Net aboveground primary productivity similarly decreased from 1,050-1,150 g/m² . yr in mesic high-elevation forests to 92-140 g/m² . yr in desert grassland and deserts. Both biomass and production show a two-slope relation to elevation (and, probably, to precipitation), with a steeper decrease from the high-elevation forests to the mid-elevation woodlands, and a less steep decrease from dry woodlands through desert grassland into desert. The two groups of communities at higher vs. lower elevations also show different relations of leaf area index and chlorophyll to elevation and to productivity. The two groups may represent different adaptive patterns: surface-limiting, with low productivity in relation to precipitation but high production efficiency in relation to surface in the more arid lower elevations, vs. surface-abundant, with high productivity relative to precipitation based on high community surface area, but lower production efficiency in relation to this area, in more humid higher elevations. Vascular plant species diversity shows no simple relation to productivity, but decreases from high-elevation fir forests to the pine forests, increases from these to the open woodlands, and decreases from dry woodlands through the desert grassland and mountain slope desert to the low bajada (creosotebush) desert. (auth)

3873 (SAND—75-0175) **Earth motions resulting from large distributed chemical explosive detonations.** Ellett, D.M. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 32p. Dep. NTIS $4.00.

Within the past several years, four of the largest conventional high-explosive shots ever fired have been set off in Arizona. All of these have been connected with a new application of the relatively old method of recovering copper from low grade ore by leaching. This method is in situ leaching of ore bodies. It is expected to increase in favor for certain deposits which have not proved to be commercially feasible to mine under modern labor costs. It is quite possible that some ore bodies worked by this method will be near inhabited areas where some inconvenience or damage could be experienced by persons and property not connected with the mine operation. Sandia Laboratories has been interested in this problem because of similar difficulties encountered in nuclear testing. Some aspects of what is currently known about the process of predicting ground motion from such shots are reviewed. Since leaching is not a widely known method of mining copper, Appendix A is included to describe the features of this type of operation. (auth)

3874 **Model for trophic interaction.** DeAngelis, D.L.; Goldstein, R.A.; O'Neill, R.V. (Oak Ridge National Lab., TN). *Ecology;* **56**: No. 4, 881-892(Sum 1975).

A nonlinear function general enough to include the effects of feeding saturation and intraspecific consumer interference is used to represent the transfer of material or energy from one trophic level to another. The function agrees with some recent experimental data on feeding rates. A model using this feeding rate functon is subjected to equilibrium and stability analyses to ascertain its mathematical implications. The analyses lead to several observations; for example, increases in maximum feeding rate may, under certain circumstances, result in decreases in consumer population and mutual interference between consumers is a major stabilizing factor in a nonlinear system. The analyses also suggest that realistic classes of consumer-resource models exist which do not obey Kolmogrov's Criteria but are nevertheless globally stable. (auth)

3875 **Population of Great Basin pocket mice, Perognathus parvus, in the shrub-steppe of south-central Washington.** O'Farrell, T.P.; Olson, R.J.; Gilbert, R.O.; Hedlund, J.D. (Battelle Pacific Northwest Labs., Richland, WA). *Ecol. Monogr.;* **45**: No. 1, 1-28(Win 1975).

A population of Great Basin pocket mice, Perognathus parvus, was live-trapped in 1967-72 on a 2.7-ha study area in south-central Washington to determine their density, reproductive performance, longevity, movements, and home range, as well as their functional role in northern shrub-steppe habitat. During 41,310 trap-nights we captured 15,386 mice representing seven species. Pocket mice accounted for 91 percent, deer mice 8 percent, and the remaining species only 1 percent of the captures. Most pocket mice remained inactive underground between December and February. Adult males became trappable at an average date of 26 March; females emerged about 18 April. Once active, adults remained trappable for an average of 60 days in years of average-to-excellent food production, and for 90 days in years of poor production. The first signs of estrus were observed in April, the first palpable pregnancies in May, and the last pregnant females usually in July. In years of high food availability adult females averaged 2 litters; in average years they had 1.1 litters; and in poor years, only one female in three became pregnant. Survival from weaning to the following breeding season ranged between 56 percent to 58 percent (1967, 1970) and 80 percent (1968); 17 percent to 19 percent survived to the 3rd yr; and 2 percent to 3 percent survived to the 4th yr. The highest overwintering success was in juveniles born during the year of lowest precipitation, poorest food supply, and reduced reproduction. Differential survival affected the age distribution of animals during the breeding season. (auth)

3876 **Small mammals: their parasites and pathologic lesions on the Arid Lands Ecology Reserve, Benton County, Washington.** O'Farrell, T.P. (Battelle Pacific Northwest Labs., Richland, WA). *Am. Midl. Nat.;* **93**: No. 2, 377-387(Apr 1975).

During May-June 1968 small mammals were sampled on the U. S. Atomic Energy Commission's Arid Lands Ecology Reserve in Benton Co., Washington. A total of 875 trap nights of effort were expended capturing 302 small mammals in seven vegetation associations at seven elevations between 750 and 3500 ft. Species included Perognathus parvus, Peromyscus maniculatus, Lagurus curtatus, Spermophilus townsendii, Eutamias minimus, Onychomys leucogaster, Thomomys talpoides and Neotoma cinerea. Perognathus and Peromyscus were caught in most of the vegetation associations sampled, although pocket mice dominated mammalian fauna at lower elevations and deer mice became dominant at higher elevations. Onychomys was trapped only in the Artemisia/Poa association, while the other species, especially L. curtatus, showed a preference for Artemisia/Agropyron. Ten species of fleas and two species of ticks were collected. Meringis shannoni was the most abundant flea and occurred on five hosts. Thrassis bacchi johnsoni, potentially one of the most important flea vectors of sylvatic plague, was collected on L. curtatus. A spectrum of minor pathologic lesions and endoparasitic burdens was documented for Perognathus and Peromyscus. (auth)

CHEMICALS MONITORING AND TRANSPORT

3877 (BNWL-SA—5571) **Sampling the environs for contamination.** Eberhardt, L.L.; Gilbert, R.O. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 11p. (CONF-751113—8). Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

Many contaminants may exhibit a highly dynamic behavior in both abiotic (atmosphere, water, and soil) and biotic systems and various kinds of mathematical models for that behavior have been developed. Guidance is lacking for the design of a sampling program for the study of a trace substance (contaminants) in any system. Because contaminants are seldom found to be uniformly spread over the landscape, it was concluded that sampling programs should be designated to fit the needs of each study. (CH)

3878 (ORNL-NSF-EATC—14) **OPTRM: a hydrologic transport model with parameter optimization.** Fields, D.E.; Watson, S.B. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 125p. Dep. NTIS $5.45.

A version of the Wisconsin Hydrologic Transport Model which incorporates a procedure for obtaining an optimal set of model parameters has been implemented. An optimal set of parameters is defined to be that set which is derived by minimiza-

tion of an objective function which quantifies the dissimilarity between observed and simulated hydrologic flow or containment transport values. Function minimization on either a monthly or a daily basis is performed by a pattern search technique. A discussion of the OPtimized TRansport Model (OPTRM) is followed by a user's guide to the model. Also included are simulations of the Walker Branch watershed in which selected sets of hydrologic and potassium transport-related parameters are determined. (auth)

3879 (ORNL-NSF-EATC—16) **Documentation and application of SCEHM. A model for soil chemical exchange of heavy metals.** Begovich, C.L.; Jackson, D.R. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 67p. Dep. NTIS $5.45.

SCEHM, a computer model simulating the transport of heavy metals through the soil system in a forested watershed, has been developed and linked with the Terrestrial Ecosystem Hydrology Model. SCEHM deals with the deposition, infiltration, exchange, and flow of particulates emitted from a smelter. Particulates are deposited onto the litter layer, dissolved and infiltrated into the soil according to a solubility constant, exchanged with the soil by using a simple K/sub d/ relationship, and transported through the soil by moisture movement. The model is applied to Crooked Creek Watershed to simulate the six-year build up of lead, cadmium, zinc, and copper around a lead smelter. The results indicate that the model can accurately predict the accumulation of heay metals which remain as free cations in the soil solution. It also can be used to help understand the individual chemistry of a particular heavy metal.The model is explained and a FORTRAN IV version is listed. Input parameters are described. Sample input and output for the model are also presented. (auth)

3880 (ORNL-tr—2982) **Liquidation of thermal electric power station waste waters: actual technical problems (in order of formulation of the question).** Kostrikin, Yu.M.; Shvetsova, V.P.; Shcherbinina, S.D. Translated by M. Gerrard from *Energetik;* No. 8, 28-29(1974). 14p. Dep. NTIS $4.00.

Methods for control of the release to the environment of petroleum-containing liquid wastes from thermal electric power stations are discussed. (CH)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

3881 (GEAP—14052) **Radiological release and dosage models.** Teresi, J.D.; Stitt, R.K. (General Electric Co., Sunnyvale, Calif. (USA). Fast Breeder Reactor Dept.). Jun 1975. Contract AT(04-3)-893. 38p. AT.

The report presents results of studies of biological and atmospheric dispersion models. The sections on biological models include a discussion of lung deposition and clearance models, biological effects models for plutonium, and application of these to plutonium aerosols from hypothetical LMFBR accidents. The limitations of the old International Commission on Radiological Protection (ICRP) lung model and the advantages of the new Task Group Lung Model (TGLM) are discussed. Sample calculations of body burdens and absorbed organ doses from exposure to plutonium released from hypothetical LMFBR accidents are compared to practical threshold model values and to nonthreshold model tumor incidence values. (auth)

3882 (LA-UR—75-2061) **Accumulation and transport of soil plutonium in liquid waste discharge areas at Los Alamos.** Hakonson, T.E.; Nyhan, J.W.; Purtymun, W.D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. (CONF-751105—7). Dep. NTIS $5.00.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

Plutonium inventory estimates for the upper 12.5 cm of sediment in Mortandad Canyon, Los Alamos, New Mexico, did not reflect all the Pu added to the canyon during a 7 month interval. The methods used in this study indicate that about 2 mCi ^{238}Pu and 0 mCi ^{239,240}Pu were added to the canyon during the interval compared with known additions of 5.5 mCi ^{238}Pu and 0.4 mCi ^{239,240}Pu. The discrepancy likely was the result of the large sampling variability indicating that inventory changes in this order (i.e. up to 17 percent) are not detectable with any certainty. However, factors other than sampling variability may be involved, including losses of plutonium to depths exceeding 12.5 cm. (auth)

3883 (NVO—153) **Radioecology of plutonium and other transuranics in desert environments. Nevada Applied Ecology Group progress report as of January 1975.** White, M.G.; Dunaway, P.B. (eds.). (Energy Research and Development Administration, Las Vegas, Nev. (USA). Nevada Operations Office). Jun 1975. 600p. Dep. NTIS $13.60.

Separate abstracts were prepared for the 21 sections of this report. (CH)

TERRESTRIAL ECOSYSTEMS AND FOOD CHAINS

3884 (ORNL-tr—2931(RD)) **Destruction of vegetation on dams of the Gorky Hydroelectric Power Plant with herbicides.** Anisimov, A.A.; Bulatova, T.A.; Valutina, V.A. Translated by M. Gerrard from *Uch. Zap. Gor'k. Gos. Univ.;* No. 98, 110-114(1970). 10p. Dep. NTIS $4.00.

The appearance of grassy and shrubby plant growth on the gravel filters of the earth dams of hydroelectric stations makes difficult, or even entirely prevents, normal filtration of water through them, which leads to emergency conditions at the dams. Several herbicides were evaluated for the complete destruction of the plant growth, including the root system, for 3 to 5 years or more; the possibility of using herbicides according to health standards; and the acquisition of herbicides in large amounts and at low cost. Simazine in 1 percent concentration (10 kg/hectare) destroyed 90 to 95 percent of the plants and in 5 percent concentration (5 kg/hectare), only 70 to 80 percent. Approximately the same action was observed with radocore. The doses mentioned may be considered as the minimum that can be used for application in cases where health requirements are higher. A mixture of 8 percent dalapon and 0.6 percent emulsion of 2,4-D butyl ester and also sodium trichloracetate (1 and 2 cwt/hectare) with borax (1 and 3 cwt/hectare) were not effective under the conditions of the earth dams of the Gorky hydroelectric station. The most resistant to treatment with simazine, diuron, and radocore were caustic stonecrop, Equisetaceae (field), and coltsfoot. A few weakened examples of these species remained in almost all sections treated with herbicides.After 2 to 3 years, a few examples of green bristle grass, white bog plants, and other annuals were found. Apparently their seeds were brought in after the treatment. Therefore mowing of the sections adjacent to the dam is suggested in order to prevent seeding of the treated sections of the dam. (CH)

SITE RESOURCE AND USE STUDIES

3885 (CONF-751122—1) **Land use suitability screening for power plant sites in Maryland.** Dobson, J.E. (Oak Ridge National Lab., Tenn. (USA)). 1975. 19p. Dep. NTIS $4.50.

From 30. annual meeting of the southeastern division of the Association of American Geographers; Pine Mountain, Georgia, USA (23 Nov 1975).

Since 1974 Oak Ridge National Laboratory (ORNL) has been engaged in developing an automated procedure for land use suitability screening. The Nuclear Regulatory Commission has funded the project to aid in the selection of power plant sites in Maryland. Its purpose is to identify candidate areas from which specific candidate sites can be chosen for detailed analyses. The ORNL approach assures that certain key variables are examined empirically for every cell in the study region before candidate sites are selected. Each variable is assigned an importance weight and compatibility score based upon its effect on the economic, social, or ecologic costs associated with construction in a given cell. The weighted scores for each variable are aggregated and output as a suitability score for each cell. (auth)

3886 (USGS—474-206) **Lithologic logs and stratigraphic units of drill holes and mined shafts in areas 1 and 6, Nevada Test Site.** Fernald, A.T.; Byers, F.M. Jr.; Ohl, J.P. (Geological Survey, Denver, Colo. (USA)). Oct 1975. Contract AT(29-2)-474. 69p. Dep. NTIS $5.45.

Lithologic logs for 21 drill holes and 2 mined shafts in Areas 1 and 6, Yucca Flat, Nevada Test Site, were compiled. All cores and cuttings were examined and, where available, g to confirm contacts between stratigraphic units. (auth)

3887 (USGS—474-220) **Geologic and geophysical field investigations at the Mine Throw III site, Split Ridge, Nevada Test Site, Nevada.** Cunningham, M.J.; Snyder, R.P. (Geological Survey, Denver, Colo. (USA)). Oct 1975. 85p. Dep. NTIS $5.45.

Geologic and geophysical field investigations were made at the Split Ridge Site of the Mine Throw III high-explosives experiment to determine the depth, uniformity, and physical properties of the rhyolite beneath the site. These data were necessary to predict the response of structures mined in the rhyolite to high-explosives detonated at the surface. Five exploratory holes were drilled at the site and continuously cored. Laboratory measurements of physical properties were made on the core. The rhyolite was found to average 67 metres in thickness, including a basal vitrophyre about 4 metres thick. Flowbanding, which is present throughout

the major portion of the rhyolite, contains vesicles that weaken the rhyolite parallel to the flowbanding. Crosshole seismic surveys disclosed a horizontal velocity anisotropy of about 2.5 to 1 that is apparently related to regional stress. Refraction seismic surveys showed lateral velocity changes which rendered layered interpretation impossible. Uphole and crosshole seismic surveys made in the exploratory drill holes revealed that seismic velocities increase with depth through three intervals in the rhyolite. (auth)

ENVIRONMENTAL SCIENCES, AQUATIC

3888 (AD—739704) **Ecological effects of offshore construction.** Rounsefell, G.A. (Marine Science Inst., Bayou La Batre, Ala. (USA)). 1972. Contract DACW-72-71-C-0002. 217p. Marine Science Inst., Bayou la Batre, AL $2.00.

Published in J. Mar. Sci., 2: No. 1, 1-89; A1-A119(1972).

The report evaluates current knowledge of the probable ecological effects of various types of offshore construction. The greatest dangers seem to lie in the placement of artificial islands within or too closely adjacent to estuaries where they can significantly affect water exchange, and in the proliferation of water cooled nuclear power plants. The effects on marine biology and water quality are discussed. Included is an annotated bibliography of 284 references. (GRA)

BASIC STUDIES

3889 (ANL/ES—40(Vol.2)) **Environmental status of the Lake Michigan region. Volume 2. Physical limnology of Lake Michigan. Part 1. Physical characteristics of Lake Michigan and its responses to applied forces. Part 2. Diffusion and dispersion.** Mortimer, C.H.; Csanady, G.T. (Argonne National Lab., Ill. (USA)). Jun 1975. Contract W-31-109-Eng-38. 121p. Dep. NTIS $5.45.

Separate abstracts were written for the two sections of the report. (SFL)

3890 (BNL—20343) **Coastal oceanographic processes.** Manowitz, B. (Brookhaven National Lab., Upton, N.Y. (USA)). May 1975. 18p. (CONF-750706—11). Dep. NTIS $4.00.

From ERDA-wide conference on computer support on environmental science and analysis; Albuquerque, New Mexico, USA (9 Jul 1975).

United States coastal zones are areas of intense activity in terms of natural physical and biological processes and show promise of being areas of intense activity with regard to man-related processes. The major energy related activities that are likely to have an impact on the coastal zones are offshore nuclear reactors and oil well drilling related activities. One of the life forms most susceptible to damage by both energy related activities is eggs and larvae of dominant fish species. There are three major sets of processes that are in need of clarification before the impact of man's activities can be appropriately assessed. These include: an understanding of hydrodynamic transport and diffusion processes both in the coastal boundary layer (approximately equal to first 10 km) and throughout the continental shelf; a broad understanding of the causes of natural fluctuations in pelagic fish populations; and a broad understanding of the processes controlling productivity on the coastal shelf. (CH)

3891 (COO—2164-13) **Fourth annual technical progress report for energy exchange within ecoecosystems. Period covered: January 1, 1976—December 31, 1976.** Gates, D.M. (Michigan Univ., Ann Arbor (USA)). 20 Sep 1975. Contract AT(11-1)-2164. 9p. Dep. NTIS $4.50.

An apparatus was developed which will continuously measure photosynthesis while maintaining light, temperature, and pH constant. Results are reported from measurements of the photosynthetic rate of Elodea densa under varying conditions of light, temperature, pH and inorganic carbon concentration. Light, temperature and pH all were found to affect photosynthetic activity. (auth)

3892 (ORNL-TM—4957) **Production dynamics of Alloperla mediana Banks (Plecoptera:Chloroperlidae) and Diplectrona modesta Banks (Trichoptera:Hydropsychidae) in Walker Branch, Tennessee.** Cushman, R.M.; Elwood, J.W.; Hildebrand, S.G. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 66p. Dep. NTIS $5.45.

The production dynamics of the immature stages of Alloperla mediana Banks, a carnivorous stonefly, and Diplectrona modesta Banks, an omnivorous caddisfly, are described in Walker Branch, a woodland stream in eastern Tennessee. Data are based on benthos samples collected monthly from December 1972 through December 1973. Alloperla mediana had a two-year life cycle, with a new cohort beginning to hatch each December but with an extended hatching period such that newly-hatched individuals appeared through the following May. Diplectrona modesta had two overlapping generations, each with a one-year life cycle. Production rates of the two species were calculated using the Hynes, removal-summation, instantaneous growth, and Allen curve methods. Estimates of total annual production rate of A. mediana and D. modesta using the four methods ranged from 97.9 to 152.9 mg m^{-2} yr^{-1} and from 564.6 to 1150.8 mg m^{-2} yr^{-1}, respectively. For each species, the lowest estimate was obtained with the "Allen curve" method and the highest estimate was obtained with the removal-summation method. For D. modesta, most of the production was from the summer generation (adult flight in the summer), with a lesser amount contributed by the spring generation (adult flight in the spring). The sources of error in the production estimates are discussed. The periods of maximum growth and production of larvae of the filter-feeding caddisfly D. modesta, which reportedly feeds largely on detritus, were related to the seasonal inputs of leaves from the terrestrial portion of the watershed. It is concluded that conditioning of the leaf litter was necessary before it could be utilized by the caddisfly. The period of maximum growth and production of the carnivorous nymphs of A. mediana was also related to the input of leaves. Thus, the stonefly depended on herbivores or omnivores to convert the leaf input into an available food source. (auth)

3893 (TID—26889) **Evaluation of the Emery Dredge for determining numbers of snails in tropical reservoirs.** Jobin, W.R.; Ferguson, F.F. (Puerto Rico Nuclear Center, San Juan). 1973. 56p. Dep. NTIS $6.00.

Since control of the aquatic snails which transmit schistosomes can be very expensive in large hydroelectric and irrigation reservoirs, it is important to understand precisely the dynamics of these snail populations in order to plan efficient programs for their control. Thus sampling methods are needed to measure the numbers of snails in the reservoirs and this report concerns the use and evaluation of the Emery dredge in nine reservoirs in Puerto Rico. The results showed that the Emery dredge could be utilized under certain conditions to accurately estimate numbers of snails in these reservoirs. In addition field results showed that Biomphalaria glabrata could be stranded by water receding very slowly and that they were highly resistant to desiccation. These results are important for planning snail control through periodic fluctuation of the water level. (auth)

3894 **Use of life tables in analyzing the dynamics of copepod populations.** Gehrs, C.W. (Oak Ridge National Lab., TN); Robertson, A. *Ecology;* **56**: No. 3, 665-672(Spr 1975).

The population parameters have been characterized for the generations that developed during a complete reproduction year of a population of the calanoid copepod Diaptomus clavipes Schacht. A model is presented to calculate the numbers of each of the various instars of a copepod produced during any previous interval of time. Life tables were constructed from laboratory data and for the five generations of the 1971 field population as an aid in studying the population dynamics. Successful reproduction in the field population occurred from mid-March until mid-October. Development time increased for successive instars of the same generation. All generations had similarly shaped survivorship curves and there was a progressively lower rate of survival in successive generations. This lower survival rate was related to decreasing survival during the early naupliar stages. Survivorship of adults was characterized by a rectangular curve. Greatest mortality rates occurred during the egg to fourth naupliar interval (N-IV) and in the sixth naupliar stage (N-VI). Critical controlling factors in this population appear to be those which affect either survivorship in the interval between egg and N-IV or reproductive activity of adults. (auth)

3895 **Nutritional analysis of a sublittoral diatom assemblage epiphytic on Enteromorpha from a Long Island salt marsh.** Lee, J.J.; McEnery, M.E.; Kennedy, E.M.; Rubin, H. (City Coll., New York). *J. Phycol.;* **11**: No. 1, 14-49(1975).

The diatom population structure of a salt marsh epiphytic community growing on Entermorpha intestinalis was studied at one station throughout the summer. A total of 218 species or varieties were recognized. Six species--Fragilaria construens, Cocconeis scutellum, Cocconeis placentula, Achnanthes hauckiana varieties, Achnanthes pinnata, and Amphora coffeaeformis (var. acutiuscula)--dominated the Enteromorpha epiphytic community during the summer months and comprised ~ 40 percent of the total populations. Melosira nummuloides, Opephora martyi, Synedra fasiculata var. tabulata, S. affinis, Navicula platyventris, and N. pavillardi were also very common species (13 percent of the total popula-

tion). The distribution of many species in the community was seasonal. A series of differential media have been developed which are effective as tools for the isolation and nutritional characterization of the algae and bacteria from the community. Many diatom species can be recognized by their colony type or growth pattern on solidified media. A key and illustrated plates aid in identification. Changes in population structure of the community were reflected by changes in the nutritional patterns as judged by differences in the growth of diatoms and bacteria on the differential media tested. The nutritional requirements, selectivity, and rank order of media for individual species is given. We conclude that the algal assemblage growing epiphytically on Enteromorpha intestinalis has a diverse auxotrophic profile which contributes to the productivity and stability within this important component of the epiphytic community and that much of the organic substrates used by individual species originate within and are recycled among the community members. (auth)

3896 **Electrophoretic study of the antarctic zooplankter Euphausia superba.** Ayala, F.J.; Valentine, J.W.; Zumwalt, G.S. (Univ. of California, Davis). *Limnol. Oceanogr.;* **20**: No. 4, 635-640(Jul 1975).

Genetic variability has been estimated for a large population of the antarctic krill, Euphausia superba, by gel electrophoresis. Of 36 loci studied, 21 (58.3 percent) exhibit allelic variation. An average individual is heterozygous at 5.8 percent of the loci, a moderately low level of variability when compared to benthic invertebrates. Low to moderately low genetic variabilities are previously recorded from benthic invertebrates in environments with highly seasonal trophic resources, and E. superba fits this relationship. (auth)

3897 **Nitrogen fixation in flax pond: a Long Island salt march.** Whitney, D.E.; Woodwell, G.M.; Howarth, R.W. (Brookhaven National Lab., Upton, NY). *Limnol. Oceanogr.;* **20**: No. 4, 640-643(Jul 1975).

Nitrogen fixation was measured by the acetylene reduction technique during summer 1973. Rates of fixation in the top 4 cm of all sediments ranged from 12 to about 800 μg N fixed m^{-2} h^{-1}. Fixation diminished with depth with none at 20 cm or below. Blue-green algal mats fixed at rates that ranged from 260 to 8,900 μg N m^{-2} h^{-1}. No fixation was detected in the tidal water column, but rates of 8.6 to 4,800 μg N $liter^{-1}$ h^{-1} occurred in small stagnant pools on the marsh surface. Rates of fixation appeared not to vary between day and night. (auth)

CHEMICALS MONITORING AND TRANSPORT

3898 (ORNL-tr—2930) **Phenol degradation in artificial bodies of water (1970 experiments).** Lapteva, N.A.; Mikryakova, T.F.; Baronkina, L.A.; Zhukov, B.F.; Goryacheva, N.V.; Zakharova, L.I. Translated by M. Gerrard from *Tr., Inst. Biol. Vnutr. Vod, Akad. Nauk SSSR;* **24**: 159-166(1973). 10p. Dep. NTIS $4.00.

Phenol as introduced daily into water which contained the aquatic plants Elodea, Lemna, and Spirogyra. At weekly intervals determinations were made on nitrate nitrogen, phosphate phosphorus, and ammonia. The water was also analyzed for bacteria, flagellates, and infusoria. Results are shown by means of graphs. (HLW)

3899 (ORNL-tr—2935) **Pattern of phenol degradation in the Volga and its tributaries.** Kostyaev, V.Ya. Translated by M. Gerrard from *Tr., Inst. Biol. Vnutr. Vod, Akad. Nauk SSSR;* **24**: 205-211(1973). 10p. Dep. NTIS $4.00.

Methods are described for taking water samples and making phenol determinations. Studies were made on the rate of phenol destruction, effects of added nitrogen and phosphorus salts on phenol destruction rate, and effects of light on phenol destruction. Results showed that neither a decrease in the pH of the water nor a decrease in oxygen concentration lead to destruction of the toxicant; only addition of nitrogen and phosphorus caused rapid destruction. It was concluded that if algae and other plants release antibiotics, they do not affect the phenol-destroying bacteria unfavorably. (HLW)

3900 (ORNL-tr—2961) **Decontamination of water contaminated with polycyclic aromatic hydrocarbons (PAH). II. Action of chlorine and ozone on PAH dissolved in drinking and river water.** Sforzolini, G.S.; Savino, A.; Monarca, S. Translated by M. Gerrard from *Ig. Mod.;* **66**: No. 6, 595-619(1974). 19p. Dep. NTIS $4.00.

Effects of chlorine and ozone on polycyclic aromatic hydrocarbons (PAH) in drinking water and river water were studied. Reactions between oxidizing agents and other chemical substances in the two kinds of water were also studied. Ozone-enriched air in a concentration of 0.40 mg/l exerted a stronger effect on the PAH than chlorine in water in a concentration of 2 mg/l. The hydrocarbon most sensitive to the action of oxidizing agents was 3,4-benzopyrene; the least sensitive was 3,4-benzofluoranthene. The variability of results of individual tests was high in river water and in de-ionized water, low or zero in doubly distilled water and in drinking water. With pyrene and 3,4-benzopyrene dissolved in doubly distilled water and in de-ionized water, in treatments with chlorine there were observed spectrophotometrically new peaks in the uv and in the low visible. (HLW)

RADIOACTIVE MATERIALS MONITORING AND TRANSPORT

3901 (CONF-721244—1) **Plutonium chemistry of the ocean.** Folsom, T.R. (Scripps Institution of Oceanography, La Jolla, Calif. (USA). Soledad Lab.). 14 Dec 1972. 8p. Dep. NTIS $4.00.

From ONR workshop on chemical oceanography; Monterey, California, USA (12 Dec 1972).

Plutonium is a man-made element whose behavior in the marine environment is inadequately known at present. It has been studied intensively in connection with production of weapons and power sources and has been characterized as an extremely toxic substance. Nevertheless, only a few dozen measurements have been made of concentrations in seawater and in the associated organisms and sediments. The first of these were as recent as 1964. There are reasons to believe its chemical behavior in the ocean is different from what has been observed on land, and that it will be difficult to predict how plutonium will distribute itself in the ocean. The consequences of increased environmental concentrations of Pu are discussed. (auth)

3902 (COO—2529-1) **Plutonium and cesium radionuclides in the Hudson River Estuary. Annual technical progress report, December 1, 1974—November 30, 1975.** Simpson, H.J.; Williams, S.C. (Columbia Univ., Palisades, N.Y. (USA). Lamont-Doherty Geological Observatory). 1975. Contract AT(11-1)-2529. 44p. Dep. NTIS $5.00.

We have obtained a large set of gravity cores from the Hudson Estuary through much of the ambient salinity range. A number of core sections have been analyzed for ^{137}Cs, ^{134}Cs, ^{60}Co, and ^{40}K by direct gamma counting, and for $^{239,240}Pu$ by alpha-spectrometry. The distribution of both ^{137}Cs and $^{239,240}Pu$ indicates rapid accumulation in marginal cove areas and in the harbor region adjacent to New York City. The distribution of both ^{137}Cs and $^{239,240}Pu$ in the sediments is quite similar in surface sediments, and the trends with depth in cores are also similar. The ratio of sediment $^{239,240}Pu$ to ^{137}Cs throughout the sampled salinity range (0-20 $^{o}/_{oo}$) approximates that in fallout, except near the nuclear reactor at Indian Point where releases of ^{137}Cs result in a ratio lower (0.004 to 0.008) than typical of fallout (0.015). Measurement amounts of reactor-derived ^{134}Cs, ^{60}Co, and ^{54}Mn are found in nearly all of the samples containing appreciable ^{137}Cs. These samples were between 15 km upstream of Indian Point reactor site and the downstream extent of our sampling, 70 km south of the reactor. (auth)

3903 (DP-MS—75-73) **Emergency response capability for pollutant releases to streams and rivers.** Buckner, M.R.; Hayes, D.W.; Watts, J.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 17p. (CONF-751101—61). Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

Stream-river models have been developed which provide an accurate prediction of normal and accidental pollutant releases to streams and rivers. Stream parameters are being developed for the Savannah River Plant streams and the Savannah River to allow quick response in case of an accidental release of radioactive material. These data are stored on permanent disk storage for quick access via the JOSHUA operating system. This system provides an efficient and flexible emergency response capability for pollutant releases to streams and rivers. (auth)

3904 (ORNL—5002) **Bioaccumulation factors for radionuclides in freshwater biota.** Vanderploeg, H.A.; Parzyck, D.C.; Wilcox, W.H.; Kercher, J.R.; Kaye, S.V. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 235p. Dep. NTIS $7.60.

This report analyzes over 200 carefully selected papers to provide concise data sets and methodology for estimation of bioaccumulation factors for tritium and isotopes of strontium, cesium, iodine, manganese, and cobalt in major biotic components of

freshwater environments. Bioaccumulation factors of different tissues are distinguished where significant differences occur. Since conditions in the laboratory are often unnatural in terms of chemical and ecological relationships, this review was restricted as far as possible to bioaccumulation factors determined for natural systems. Because bioaccumulation factors were not available for some shorter-lived radionuclides, a methodology for converting bioaccumulation factors of stable isotopes to those of shorter-lived radionuclides was derived and utilized. The bioaccumulation factor for a radionuclide in a given organism or tissue may exhibit wide variations among bodies of water that are related to differences in ambient concentrations of stable-element and carrier-element analogues. To account for these variations, simple models are presented that relate bioaccumulation factors to stable-element and carrier-element concentrations in water. The effects of physicochemical form and other factors in causing deviations from these models are discussed. Bioaccumulation factor data are examined in the context of these models, and bioaccumulation factor relations for the selected radionuclides are presented. (auth)

3905 (ORNL-tr—2950) **Plant bioindicators of water-channel contamination due to a nuclear (PWR) power plant effluent.** Kirchman, R.; Lambion, J. Translated by E.G. Silver from *Bull. Soc. R. Bot. Belg.*; **106**: 187-201(1973). 17p. Dep. NTIS $4.50.

In the outline of a general program of environmental surveillance around nuclear power stations, several aquatic and ripicolous plants were checked as possible bioindicators of water contamination and of its variations during the course of time. The data-collecting network for surveillance was set up with the purpose of determining the environmental dispersion of radioactive liquid effluents. The comparison of different plant species emphasizes the difficulties of the use of helophytes; it leads to the choice of aquatic mosses, particularly Cinclidotus tambicus, as biological indicators. Response of this species at a point situated at about 15 km downstream of the nuclear power station was analyzed during a period larger than three years. At last, the contamination levels of this indicator at some points of the stream of the river Meuse are compared at an interval of two years; results are discussed, specially in connection with the activity levels of the releases. (auth)

3906 (BNL-tr—612) **Sorption of ^{238}Pu, ^{106}Ru, and ^{99}Tc by bottom sediments in the Pacific Ocean.** Gromov, V.V.; Spitsyn, V.I. Translated from *Radiokhimiya;* **16**: No. 2, 157-162(1975). 19p. Dep. NTIS $4.50.

The absorption of trace amounts of ^{238}Pu, ^{106}Ru, and ^{99}Tc by the most abundant sediments of the Pacific Ocean (deep-water red clay, carbonate sediment, diatomic silt, and hydrogenous sediment was investigated. The radioactive products were found to be sorbed most efficiently by red clay and carbonate sediment. The radioactive isotopes studied may be arranged in the following sequence relative to the degree of absorption: ^{106}Ru greater than ^{239}Pu greater than ^{99}Tc. Several equilibrium physicochemical forms were shown to correspond to the given radioactive isotopes in sea water: ^{106}Ru has several sorbable forms, ^{239}Pu is characterized by at least one sorbable and one nonsorbable form, and ^{99}Tc presumably exists in the form of a not readily sorbable anion, TcO_4^-. (auth)

WATER

3907 (ORNL-TM—4777, pp 149-165) **Environmental studies.** Jul 1975.

In Experimental Engineering Section semiannual progress report.

Automated, high-resolution chromatography was used for the determination of trace organics present in two types of polluted waters: sewage treatment plant effluents, and natural waters. Fifty-six organic compounds have been identified as present (at microgram-per-liter levels) in effluent samples from the primary stage of domestic sewage treatment plants, and 13 have been identified in effluent samples from the secondary stage. Chlorinated cooling waters and other waters containing low concentrations of orga8ics were evaluated for possible formation of chlorinated organics. Forty-six chlorine-containing organic constituents were separated from a chlorinated sample of lake water. Preliminary results indicate that two possible compounds are 5-chlorouracil (0.3 ppb) and 4-chlororesorcinol (0.05 ppb). (PCS)

SITE RESOURCE AND USE STUDIES

3908 (LA—6086—MS) **Evaluation of yield and water-level relations.** Cushman, R.L.; Purtymun, W.D. (Los Alamos Scientific Lab., N.Mex. (USA)). Oct 1975. Contract W-7405-ENG-38. 14p. Dep. NTIS $4.00.

Yield and water relations in the Los Alamos supply wells were evaluated because of the increasing demand for water. Water-level declines were extrapolated for 10 yr, to 1983, on the basis of past records. On the basis of current pumpage, the extrapolations indicate that nonpumping water levels in individual wells will decline from 10 to 30 ft. Well characteristics were compiled to provide an individual history of each well, and recommendations for improving water production are presented. (auth)

BIOMEDICAL SCIENCES, basic studies

3909 **Restraint, venipuncture, endotracheal intubation, and anesthesia of miniature swine.** Ragan, H.A.; Gillis, M.F. (Battelle Pacific Northwest Labs., Richland, WA). Contract AT(45-1)-1830. *Lab. Anim. Sci.*; **25**: No. 4, 409-419(1975).

Miniature swine are useful as experimental animals for investigations involving major surgical procedures, provided that proper restraint and anesthetic methods are employed. The methods and drugs described herein are not intended to be all-inclusive but rather those found most applicable to a wide variety of studies with miniature swine at this laboratory. This report is intended primarily to guide those unfamiliar in handling miniature swine during initiation of studies with that species. For chemical restraint during minor procedures, diazepam, at a dose of 5.5-8.5 mg/kg im, has become the drug of choice. For surgical anesthesia, optimal results have been obtained using thiamylal sodium iv for induction of anethesia and maintained by 0.5-1.5 percent halothane administered via an endotracheal cannula. Pentobarbital sodium may be used to produce surgical anesthesia but is generally unsatisfactory except for terminal procedures. Electroanesthesia, even with concomitant use of tranquilizing drugs, is difficult to control and results in very poor muscle relaxation. (auth)

BEHAVIORAL BIOLOGY

3910 **Light-scattering study of the temperature dependence of Escherichia coli motility.** Banks, G.; Schaefer, D.W.; Alpert, S.S. (Sandia Labs., Albuquerque, NM). *Biophys. J.*; **15**: No. 3, 253-261(Mar 1975).

Two light-scattering techniques are used to study the temperature dependence of translational and rotational motility in Escherichia coli. The method of number fluctuation spectroscopy is developed theoretically and experimentally to measure the translational swimming speed of a smooth swimming strain of E. coli. Interference fluctuation techniques are used to study the rotational component of the motion. The results demonstrate that the thrust remains proportional to the torque generated by the flagella throughout the range studied and also show the relative changes in translational swimming speed may be inferred from the dynamics of rotational motion. (auth)

BIOCHEMISTRY

3911 (COO—1599-95) **Investigations on the role of dissolved organic matter in determining ecosystem structure and function: the plankton and photoheterotrophy.** McKinley, K.R. (Michigan State Univ., Hickory Corners (USA). W.K. Kellogg Biological Station). 1975. 149p. Dep. NTIS $7.00.

Thesis.

Within the broader context of the cycling of dissolved organic materials, this study examines the occurrence of the phenomenon of photoheterotrophy, the light-mediated assimilation or organic compounds at or near natural substrate concentrations, in the phytoplankton of lake systems. The pelagic zone of Lawrence Lake, an oligotrophic, dimictic, temperate, hard-water lake in southwestern Michigan, was selected as the study site and data are reported for time, depth, and month of sampling. The uptake of an organic compound, glucose, and photolithotrophic carbon fixation were monitored simultaneously. Light and dark bottle uptake of organic and inorganic carbon was measured throughout the annual period during three sampling peods throughout the daylight hours and at three depths within the water column. It was concluded that photoheterotrophy represents a key feedback loop at a trophically significant level and may play an important determining role in phytoplankton succession and community structure over time. (CH)

3912 (ORO—4310-4) **Primary light harvesting system: phycobilisomes and associated membranes. Progress report, 1 January—31 December 1975.** Gantt, E. (Smithsonian Institution, Rockville, Md. (USA). Radiation Biology Lab.). 1975. Contract AT(40-1)-4310. 10p. Dep. NTIS $4.00.

As light harvesting antennae, phycobilisomes are structured for maximum energy transfer occurring from phycoerythrinyieldsphycocyaninyieldsallophycocyaninyieldschlorophyll (within the photosynthetic membrane). Evidence has been presented which supports such an in vivo phycobiliprotein arrangement. Supporting data was obtained from phycobilisomes, isolated in high strength phosphate buffer, which were analyzed by selective dissociations, fluorescence, immunoprecipitation, and electron microscopy. Allophycocyanin is presumed to constitute an attachment site with the lamellae in both the red algal and blue-green algal phycobilisomes. Localization of allophycocyanin on the surface of blue-green algal phycbilisomes has been shown, but its localization in the lamellae has not yet been possible. Studies on aggregation properties of phycocyanin and allophycocyanin indicate that spectral shifts occur toward the longer wavelength regions, this is particularly striking in the fluorescence emission of concentrated solutions of allophycocyanin. It was conclusively shown that chlorophyll fluorescence does not contribute to the 675 nm emission which has been attributed to allophycocyanin. Phycobiliprotein content can be regulated by the nitrate content of the cell growth medium. Cells deficient in phycobiliproteins lacked phycobilisomes, but were still viable as indicated by the measured oxygen evolutionand their ability to synthesize phycobiliproteins when nitrate was supplied to the medium. Chlorophyll and phycoerythrin synthesis had a parallel time course. Phycobilisome type aggregates were compared in three related red algal species which are natural pigment variants. The aggregate morphology varies with the species and appears to be dependent on the ratio of phycobiliproteins present. (auth)

3913 (UCRL—77123) **Rabbits as a model for the study of hyperlipoproteinemia and atherosclerosis.** Shore, B.; Shore, V. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Aug 1975. 20p. (CONF-750843—1). Dep. NTIS $4.00.

From Symposium of anti-atherosclerotic drug discovery; Augusta, Michigan, USA (Aug 1975).

Lipoproteins of normal and cholesteremic plasma were compared in New Zealand White (hyperresponder) and Dutch Belt (hyporesponder) rabbits. Three major differences were observed between the strains: New Zealand White rabbits developed much higher plasma levels of very low, intermediate, and low density lipoproteins after cholesterol feeding; Dutch Belt rabbits, normal and cholesteremic, had higher ratios of the more dense high density lipoproteins HDL_3 (d 1.125-1.20 g/ml) to the less dense HDL_2 (d 1.081-1.125 g/ml); cholesteremic Dutch Belt rabbits had higher plasma levels of the more dense HDL_3 subfraction than did cholesteremic New Zealand White rabbits. Cholesteremic very low density lipoproteins of both strains are large particles of beta electrophoretic mobility that are rich in cholesteryl esters and an arginine-rich apolipoprotein(s). The intermediate and low density lipoprotein fractions were similarly altered in composition, although the proportion of arginine-rich protein to total protein was less than in the very low density fraction. Although the high density lipoproteins were greatly decreased in concentration in cholesteremic plasma, no major changes in their apolipoproteins were seen in either strain of rabbits. The major high density apolipoprotein of rabbits occurs in two electrophoretically separable forms and is similar to human apo A-I. Six minor apolipoproteins were isolated from the high density lipoproteins; some of these occur also in other density fractions. Erythrocyte membranes of both strains of rabbits before and after cholesteremia were quantitatively similar in their Na^+-K^+-ATPase, Mg^{++}-ATPase, and Ca^{++}-ATPase activities. (auth)

3914 **Influence of pH on the interaction of inhibitors with triosephosphate isomerase and determination of the Pk/sub a/ of the active-site carboxyl group.** Hartman, F.C. (Oak Ridge National Lab., TN); LaMuraglia, G.M.; Tomozawa, Y.; Wolfenden, R. *Biochemistry*; **14**: No. 24, 5274-5279(2 Dec 1974).

Ionization effects on the binding of the potential transition state analogues 2-phosphoglycolate and 2-phosphoglycolohydroxamate appear to be attributable to the changing state of ionization of the ligands themselves, therefore it is unnecessary to postulate the additional involvement of an ionizing residue of the active site of triosephosphate isomerase to explain the influence of changing pH on k/sub i/ in the neutral range. The binding of the competitive inhibitor inorganic sulfate is insensitive to changing pH in the neutral range. 3-Chloroacetol sulfate, synthesized as an active-site-specific reagent for triosephosphate isomerase, is used to provide an indication of the pK/sub a/ of the essential carboxyl group of this enzyme. Previously described active-site-specific reagents for the isomerase were phosphate esters, and their changing state of ionization (accompanied by possible changes in their affinity for the active site) may have complicated earlier attempts to determine the pK/sub a/ of the essential carboxyl group from the pH dependence of the rate of inactivation. Being a strong monoprotic acid, chloroacetol sulfate is better suited to the determination of the pK/sub a/ of the carboxyl group. Chloroacetol sulfate inactivates triosephosphate isomerase by the selective esterification of the same carboxyl group as that which is esterified by the phosphate esters described earlier. From the pH dependence of the rate of inactivation of yeast triosephosphate isomerase, the apparent pK/sub a/ of the active-site carboxyl group is estimated as 3.9 +- 0.1. (auth)

3915 **Primary photochemical reactions in chloroplast photosynthesis.** Beaden, A.J.; Malkin, R. (Univ. of California, Berkeley). *Q. Rev. Biophys.*; **7**: No. 2, 131-177(1975).

A review of studies on photochemical reactions in chloroplast photosynthesis is presented. Studies reviewed are concerned with two different photoreactions, each with its own separate pigment system. One photoreaction, designated Photosystem II, operates efficiently in red light and produces a strong oxidant that is sufficiently electropositive to oxidize water to oxygen and concomitantly generates a weak reductant. The second photoreaction, designated Photosystem I, operates efficiently in far-red light and produces a strong reductant which is sufficiently electronegative to reduce pyridine nucleotide and concomitantly generates a weak oxidant. (HLW)

3916 **Selection by [^{3}H] amino acids of CHO-cell mutants with altered leucyl- and asparagyl-transfer RNA synthetases.** Thompson, L.H. (Univ. of California, Livermore); Stanners, C.P.; Siminovitch, L. *Somatic Cell Genet.*; **1**: No. 2, 187-208(1975).

Efficient selection procedures, using [^{3}H]amino acids as the selecting agent, were developed for isolating temperature-sensitive (TS) mutations in CHO cells affecting protein synthesis. After chemical mutagenesis, leucyl-tRNA synthetase mutants were obtained when [^{3}H]leucine was used as the selecting agent in two independent experiments. These mutations seem to involve the same genetic locus as the TSH1 mutant described previously. A selection with [^{3}H]valine, in which all amino acids except leucine were at low concentration in the selective medium, resulted in a new class of mutants with reduced asparagyl-tRNA synthetase activity. These results were consistent with the finding that all mutants were phenotypically dependent on the concentration of amino acid, specific to the altered synthetase, in the medium. Our observations suggest that although leucyl synthetase mutations are a relatively common class of TS mutations in CHO cells, the spectrum of mutants obtained can be at least partially manipulated through concentrations of amino acids in selective media. The asparagyl-synthetase mutation was shown to be recessive and to complement the leucyl-synthetase mutation in cell-cell hybrids. (auth)

3917 **Stimulation of human erythrocyte Mg^{++}-ATPase by plasma lipoproteins.** Shore, V.; Shore, B. (Univ. of California, Livermore). *Biochem. Biophys. Res. Commun.*; **65**: No. 4, 1250-1256(1975).

Human erythrocyte Mg^{++}-ATPase, but not Na^+-K^+-ATPase or Ca^{++}-ATPase, was markedly stimulated by the very low density and low density lipoproteins of plasma and by their phospholipid-apolipoprotein complexes. Their essentially lipid-free protein moieties and certain of their apolipoprotein subfractions also were stimulatory. The high density lipoproteins of plasma caused little or no stimulation of the ATPases. The results suggest a possible mechanism for modulation of cell function consequent to binding of the lipoproteins to the cells. (auth)

3918 **Coagulation-time determination with automatic multivariable analysis, by use of a miniature centrifugal fast analyzer.** Bostick, W.D.; Bauer, M.L.; Morton, J.M.; Burtis, C.A. (Oak Ridge National Lab., TN). *Clin. Chem.*; **21**: No. 9, 1288-1293(1975).

Use of a miniature Centrifugal Fast Analyzer for the parallel photometric monitoring of the coagulation process is shown to have a number of advantages. These include a choice of optical modes, virtually simultaneous initiation and observation of the coagulation process for a number of patient-plasma samples and an on-board control sample, small sample and reagent volume requirements, and automatic determination of a number of diagnostically useful variables (including relative fibrinogen content) from the data recorded in a single run. Also, the system is shown to give results that correlate well with those obtained by conventional techniques for determination of prothrombin time. (auth)

3919 **Studies on the reduction of 2,3,5-triphenyltetrazolium chloride as a viability assay for plant tissue cultures.** Towill, L.E.; Mazur, P. (Oak Ridge National Lab., TN). *Can. J. Bot.*; **53**: No. 11, 1097-1102(1975).

Optimum conditions for the reduction of 2,3,5-triphenyltetrazolium chloride (TTC) to a water-insoluble red formazan have been determined for suspension tissue cultures of Acer saccharum and Haplopappus gracilus. The standard incubation mixture is 0.8 percent TTC dissolved in a 2:1 solution of 0.05 M sodium phosphate buffer: Acer growth medium, pH 7.5. After the cells are incubated for 18-20 h in the dark at room temperature, the red formazan is extracted with 95 percent ethanol, and the absorbance is read at 485 nm. The use of the TTC procedure as a viability assay is supported by studies with Haplopappus tissue cultures, in which viability can be assayed by both plating in agar and the TTC procedure. These studies show that there is a quantitative correspondence between the decrease in the plating assay and in the TTC assay when these cells are subjected to freezing stress and plasmolysis stress. (auth)

3920 Polypeptide A-II of serum high density lipoproteins: a lipophilic protein of phylogenetic interest. Scanu, A.M. (Univ. of Chicago). *PAABS Rev.;* **4**: No. 1-2, 1-11(1975). (In English and Spanish).

The molecular structure of the polypeptide A-II is shown by means of a diagram and characteristics of the molecule are discussed. The importance of the helical conformation in lipid binding is pointed out. Data obtained with high density lipoproteins (HDL) of rhesus monkeys are discussed. A significant finding is the existence in the rhesus monkey of A-II in monomeric form. The existence of A-II monomers in HDL was also established for the baboon, the squirrel monkey, Cebus monkey, and the gibbon. (HLW)

3921 Effect of formaldehyde on the circular dichroism of chicken erythrocyte chromatin. Senior, M.B.; Olins, D.E. (Univ. of Tennessee, Oak Ridge). *Biochemistry;* **14**: No. 15, 3332-3337(1975).

Formaldehyde (HCHO) fixation of chicken erythrocyte chromatin produces a marked decrease in its positive circular dichroism (CD), above 260 nm, and the appearance of a small negative ellipticity around 295 nm. The ultraviolet spectrum of chromatin is unaffected, nor does HCHO produce any changes in the uv or CD spectra of chicken erythrocyte DNA. The extent of the circular dichroism transition for the native chromatin to the suppressed spectrum is dependent on the concentration of HCHO and salt concentration. The kinetics of the reactions are complex, implicating at least two reactive species. Studies of the reaction of HCHO with chromatin in ethylene glycol and CD measurements of aqueous chromatin solutions with added glutaraldehyde preclude simple dehydration and general cross-linking effects as causes of the CD changes observed. The results are interpreted as indicating a conformational change of the DNA in chromatin caused by histone-DNA or histone-histone cross-linking. (auth)

3922 Urea denaturation of chromatin periodic structure. Carlson, R.D.; Olins, A.L.; Olins, D.E. (Univ. of Tennessee, Oak Ridge). *Biochemistry;* **14**: No. 14, 3122-3125(1975).

Isolated chicken erythrocyte nuclei dispersedn urea solutions (0-5.0 M) have been examined in terms of their low-angle X-ray diffraction and electron microscopic properties. At high urea concentrations, the characteristic low-angle X-ray reflections of chromatin are absent, and the spheroid chromatin particles (ν bodies) are markedly perturbed. This lability of chromatin periodic structure to high concentrations of urea is consistent with previous hydrodynamic and spectroscopic studies. (auth)

3923 Rapid component of electron paramagnetic resonance signal II: a candidate for the physiological donor to photosystem II in spinach chloroplasts. Babcock, G.T.; Sauer, K. (Univ. of California, Berkeley). *Biochim. Biophys. Acta;* **376**: 329-344(1975).

Rapid light-induced transients in EPR Signal IIf($F.^+$) are observed in 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU)-treated, Tris-washed chloroplasts until the state F P680 Q^- is reached. In the absence of exogenous redox mediators several flashes are required to saturate this photoinactive state. However, the Signal IIf transient is observed on only the first flash following DCMU addition if an efficient donor to Signal IIf, phenylenediamine or hydroquinone, is present. Complementary polarographic measurements show that under these conditions oxidized phenylenediamine is produced only on the first flash of a series. The DCMU inhibition of Signal IIf can be completely relieved by oxidative titration of a one-electron reductant with $E'_{ox\text{-}0} = +480$ mV. At high reduction potentials the decay time of Signal IIf is constant at about 300 ms, whereas in the absence of DCMU the decay time is longer and increases with increasing reduction potential. A model is proposed in which Q^-, the reduced Photosystem II primary acceptor, and D, a one-electron 480 mV donor endogenous to the chloroplast suspension, compete in the reduction of Signal IIf ($F.^+$). At high potentials D is oxidized in the dark, and the ($Q^- + F.^+$) back reaction regenerates the photoactive F P680 Q state. The electrochemical and kinetic evidence is consistent with the hypothesis that the Signal IIf species, F, is identical with Z, the physiological donor to P680. (auth)

3924 Amino-terminal sequences of the anti-tumor lectin ricin A- and B-chains. Li, S.S.L. (Mount Sinai School of Medicine, New York); Wei, C.H.; Lin, J.Y.; Tung, T.C. *Biochem. Biophys. Res. Commun.;* **65**: No. 4, 1191-1195(1975).

The amino-terminal sequence of 28 and 14 residues of A- and B-chains of ricin, respectively, obtained from the seeds of Ricinus communis (castor bean) were determined with automatic Edman degradation. (auth)

3925 Covalent structural analysis of yeast inorganic pyrophosphatase. Sterner, R.; Heinrikson, R.L. (Univ. of Chicago). *Arch. Biochem. Biophys.;* **168**: 693-703(1975).

Covalent structural analysis of two of the three cyanogen bromide fragments from yeast inorganic pyrophosphatase (EC 3.6.1.1, pyrophosphate phosphohydrolase) was undertaken by a strategy involving both automated Edman degradation and conventional sequence analysis. Automated degradation of intact, reduced and carboxymethylated pyrophosphatase provided the sequence of the first 34 residues in the NH_2-terminal 45-residue peptide, CNBr VI, in addition to a partial sequence through 50 cycles which confirmed the overlap into the internal fragment, CNBr III. The sequence of CNBr VI was completed through analysis of peptides derived from hydrolysis of the fragment with trypsin and chymotrypsin. Structural analysis of CNBr III has provided the sequence of the first 55 amino acids in this 103-residue fragment. The sequence was established by conventional and automated procedures applied to the analysis of tryptic peptides generated from the citraconylated fragment. These findings constitute the sequence of the first 100 residues in the pyrophosphatase subunit and, together with structural information obtained earlier, define over half of the covalent structure of the molecule. Moreover, the sequence derived thus far permits the placement of a number of amino acids that are of importance relative to studies of the enzyme mechanism, and with regard to analysis of its three-dimensional structure. (auth)

3926 Arrangement of lipid and protein in human serum high density lipoproteins: a proposed model. Verdery, R.B. III; Nichols, A.V. (Univ. of California, Berkeley). *Chem. Phys. Lipids;* **14**: 123-124(1975).

Based on size and compositional data, models for the two major density subclasses of human serum high density lipoproteins have been developed. Descriptions of both the surface structure of the high density lipoproteins and the structure of their apolar core regions are integral parts of these models. The surface is described as a mosaic of amphiphilic lipid and helical protein regions. The conformation and orientation of the various apolar lipid components as restricted by the surface organization is discussed. (auth)

3927 Isolation and properties of the specific binding sites for Escherichia coli RNA polymerase on T4 and T7 bacteriophage DNAs. Niyogi, S.K.; Underwood, B.H. (Oak Ridge National Lab., TN). *J. Mol. Biol.;* **94**: 527-535(1975).

RNA polymerase of Escherichia coli was allowed to bind to labeled T4 or T7 bacteriophage DNA. The unbound and "weakly" bound polymerase molecules were removed by adding an excess of poly(I) which has a high affinity for the enzyme (Bautz et al., 1972). After the unbound DNA regions were digested with pancreatic DNAase and snake venom phosphodiesterase, the protected DNA—RNA polymerase complexes were isolated by Sephadex G200 column chromatography. The protected DNA sites were then isolated by phenol extraction and hydroxylapatite chromatography. No binding is observed in the absence of the sigma subunit or at low temperatures. The amount of protection ranges from 0.18 percent to 0.24 percent of T4 DNA and from 0.25 percent to 0.34 percent of T7 DNA. In the absence of poly(I), higher protections are observed and the protected regions display heterogeneity in size and secondary structure. The protected regions are double-stranded, as shown by hydroxylapatite chromatography, base composition analysis, and thermal chromatography. The length of the protected regions comprise about 50 to 55 nucleotide pairs, as suggested by end-group analysis, sucrose density-gradient centrifugation, and polyacrylamide gel electrophoresis. The results suggest the interaction of dimeric polymerase molecules at these sites. On the basis of DNA sizes, there are 7 to 9 such sites on T4 DNA and 2 to 3 on T7 DNA. The protected regions are high in (A + T): 68 percent for T4 and 62 percent for T7 DNA. Thermal chromatograms reflect these base compositions and suggest the homogeneity of these regions with respect to size and base composition. (auth)

3928 5-methyltetrahydrofolate aromatic alkylamine N-methyltransferase: an artefact of 5,10-methylenetetrahydrofolate reductase activity. Taylor, R.T.; Hanna, M.L. (Univ. of California, Livermore). *Life Sci.*; **17**: 111-119(1975).

A previously reported stimulation of brain 5-methyltetrahydrofolate (5-MeH_4-folate) N-methyltransferase by FAD and methylcobalamin (MeB_{12}) is attributed to their roles as nonspecific electron acceptors. Evidence is presented that the catalyst involved is not an aromatic alkylamine methyltransferase, but the widely distributed enzyme, 5, 10-methyleneH_4-folate reductase. In the presence of an electron acceptor it catalyzes the oxidation of [5-^{14}C]MeH_4folate to [5,10-^{14}C]methyleneH -folate which equilibrates to yield dimedone reactive H^{14}CHO. The material being measured when incubation systems containing β-phenylethylamine or tryptamine are extracted with toluene-isamyl alcohol is a condensation product of the H^{14}CHO and the aromatic alkylamine. The aromatic alkylamine is not a co-substrate in the enzymic oxidation mechanism. It is required to react nonenzymically with reductase formed H^{14}CHO and render it extractable. Our failure and that recently of others to detect significant N-methylation using [5-^{14}C]MeH_4-folate as a Me group donor make the existence of a folate-biogenic amine methyltransferase seem highly improbable. (auth)

3929 Induction of neurogenic tumors by nitrosotrialkylureas in rats. Lijinsky, W.; Taylor, H.W. (Oak Ridge National Lab., TN). *Z. Krebsforsch.*; **83**: 315-321(1975).

Four nitrosotrialkylureas were each fed to groups of 15 male and 15 female Sprague-Dawley rats for 50 weeks in drinking water at the same molar concentration. Tumors of nervous origin arose after treatment with nitrosotrimethylurea (3/30), nitrosotriethylurea (7/30), nitrosomethyldiethylurea (23/30), and nitrosoethyldimethylurea (8/30). A comparison of the relative stabilities of the four nitrosoureas in aqueous solution at various pH's showed no correlation with the tumorigenicities of the compounds. (auth)

3930 Discussion paper: dimethyl sulfoxide as a cryoprotective agent for platelet preservation by freezing. Baldini, M.G. (Brown Univ., Providence). *Ann. N.Y. Acad. Sci.*; **243**: 306-307(27 Jan 1975).

A method for preserving platelets by freezing using DMSO is described. This method is thought to be ideal in the sense that platelet viability and hemostatic effectiveness can be preserved for long intervals in the frozen state. This method is not routinely applied in hospitals due to lack of approval by the Food and Drug Administration. (HLW)

3931 Carbodiimide enhancement of complement-dependent antibody-mediated tumor cell lysis in vitro and antitumor activity in vivo. Fawwaz, R.A.; Tenforde, T.S.; Mehlberg, W.H. (Univ. of California, Berkeley). Contract W-7405-eng-48. *Cancer Res.*; **35**: 679-686(Mar 1975).

The water-soluble carbodiimide salt 1-ethyl-3-(3'-dimethylaminopropyl) carbodiimide.HCl (EDCI.HCl) has been shown to increase the complement-dependent lysis of cultured mouse neuroblastoma C1300 cells by two types of antibody: (1) natural antibodies in the sera of normal (nonimmunized) rabbits, and (b) serum antibodies from syngeneic tumor-bearing A/HeJ mice. In the latter case, both the level of serum antibodies and the extent of carbodiimide enhancement of immune lysis were demonstrated in vitro to be substantially greater with sera from mice bearing 21-day-old tumors relative to 4-day-old tumors. The carbodiimide EDCI.HCl has also been found to increase the complement-dependent lysis of cultured TA3 carcinoma cells by serum antibodies from isogeneic LAF_1/J mice bearing ascites tumors in advanced stages of growth. Finally, it has been shown that EDCI.HCl exerts an antitumor activity in vivo that is significantly greater against 21-day-old than against 4-day-old neuroblastoma C1300 tumors. The increase in EDCI.HCl activity with tumor age is contrary to the response that would be expected if this drug were serving as an antimetabolite. This is evidenced by data showing that the antimetabolite 6-thioguanine is most effective against young, rapidly growing neuroblastoma C1300 tumors. The correlation between carbodiimide antitumor activity and host production of cytotoxic antibodiessuggests that EDCI.HCl may operate in vivo by an immunological mechanism comparable to that demonstrated in vitro. (auth)

3932 Sequential phosphorylation of histone subfractions in the Chinese hamster cell cycle. Gurley, L.R.; Walters, R.A.; Tobey, R.A. (Los Alamos Scientific Lab., NM). *J. Biol. Chem.*; **250**: No. 10, 3936-3944(25 May 1975).

Ion exchange chromatography and preparative electrophoresis were used to examine the phosphorylation of histone f1 and f3 subfractions in synchronized Chinese hamster cells (line CHO). Three discrete f1 phosphorylation events were demonstrated to occur in sequence during the cell cycle. The first event (f1/sub G_1/ commenced in G_1 2 hours prior to entry of cells into S phase; the second event (f1/sub s/) commenced simultaneously with initiation of DNA synthesis; and the third event (f1/sub M/) commenced when cells entered mitosis. F1/sub M/ phosphorylation occurred simultaneously with the phosphorylation of histone f3 (which is not phosphorylated during G_1, S, or G_2). Fractionation of f1 and f3 revealed no differences in these sequential phosphorylation patterns among the various f1 and f3 subfractions, indicating that these phosphorylations are general biochemical events of the cell cycle. Phosphorylated (f1/sub G_1/ was found to accumulate in cells as they traversed their cell cycle. F1/sub s/ was phosphorylated to twice the extent of f1/sub G_1/, but f1/sub s/ did not accumulate in the cells as they passed through interphase. F1/sub M/ was phosphorylated to about 4 times the extent of the first phosphorylated form (f1/sub G_1/). A model of the relationship of histone phosphorylation to the cell cycle is presented which suggests that f1/sub G_1/ phosphorylation is involved with chromatin structural changes necessary for cell proliferation;f1/sub s/phosphorylation is involved with DNA replication; F1/sub M/ and f3 phosphorylations are involved in chromosome condensation. (auth)

3933 Purification, properties, and crystallographic data for a principal nontoxic lectin from seeds of Abrus precatorius. Wei, C.H.; Koh, C.; Pfuderer, P.; Einstein, J.R. (Oak Ridge National Lab., TN). *J. Biol. Chem.*; **250**: No. 12, 4790-4795(Jun 1975).

Nontoxic abrus lectin has been prepared by a new purification procedure. The method is accomplished by 45 percent saturation ammonium sulfate fractionation from a 5 percent acetic acid extract of the seeds of Abrus precatorius followed by diethylaminoethyl-Sephadex A-50 and Sepharose 4B affinity chromatography. The abrus lectin appeared homogeneous as judged by electrophoresis, analytical ultracentrifugation, and isoelectric focusing. The lectin molecule has a weight of 126,000, as determined by sedimentation equilibrium. It is composed of four subunits, of which two pairs have either identical or closely similar molecular sizes (33,800 and 32,200 daltons) as revealed by polyacrylamide gel electrophoresis in the presence of sodium dodecyl sulfate. The results of amino acid analyses are given; none of the cysteic acid appears to arise from cysteine. An electrofocusing experiment indicated the isoelectric point to be 5.0. Crystals large enough for x-ray investigation were obtained by a vapor diffusion technique. X-ray precession photographs revealed that abrus lectin crystallizes in a tetragonal unit cell of symmetry $P4_12_12$ and dimensions a = 140 and c = 210 A. The asymmetric unit contains 2 protein molecules of molecular weight 126,000 and has a solvent content of approximately 41 percent by volume. (auth)

3934 Ability of tryptophan tRNA to hybridize with 35S RNA of avian myeloblastosis virus and to prime reverse transcription in vitro. Waters, L.C.; Mullin, B.C.; Ho, T.; Yang, W.K. (Oak Ridge National Lab., TN). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 6, 2155-2159(Jun 1975).

Selected species of 4S RNA of chick embryo cells will hybridize in vitro with 35S RNA of avian myeloblastosis virus. A major tRNA component of the hybridizable 4S RNA is tryptophan tRNA. A hybrid prepared from purified tryptophan tRNA and 35S RNA of avian myeloblastosis virus in vitro is an efficient template-primer for DNA synthesis catalyzed by reverse transcriptase (RNA-dependent DNA polymerase). (auth)

3935 Cytochrome synthesis in synchronous cultures of the yeast, Saccharomyces cerevisiae. Cottrell, S.F.; Rabinowitz, M.; Getz, G.S. (Univ. of Chicago). *J. Biol. Chem.*; **250**: No. 11, 4087-4094(10 Jun 1975).

The synthesis of cytochromes aa_3, b, and c has been investigated during synchronous growth in the yeast, Saccharomyces cerevisiae. These cytochromes increase in concentration continuously throughout each cell cycle, with an approximate doubling in rate during successive cycles. The rates of cytochrome formation are considerably higher in galactose-grown cultures than in cells grown in glucose. Although cytochrome aa_3 increases at a continuous rate, its functional counterpart, cytochrome c oxidase, increses in stepwise fashion, with the increments occurring at the beginning of each new cell cycle. Chloramphenicol, a specific inhibitor of intramitochondrial protein synthesis, inhibits the formation of cytochrome aa_3 at all stages of the cell cycle, but does not inhibit cytochrome c. Chloramphenicol exhibits a somewhat intermediate effect on cytochrome b synthesis, with transient inhibition occurring only when the drug is added prior to or during the initial part of the first cell cycle. After this time, chloramphenicol had no effect on the rate of cytochrome b synthesis. The data indicate that under our conditions of cell synchrony, mitochondrial membrane formation as reflected by increments in mitochondrial cytochromes occurs by continuous accretion of new material throughout the cell cycle. Intramitochondrially synthesized polypeptide products, responsible for the formation of new cytochrome aa_3, appear to be synthesized throughout the cell cycle. (auth)

3936 Removal of Z-lines and α-actinin from isolated myofibrils by a calcium-activated neutral protease. Reddy, M.K.; Etlinger, J.D.; Rabinowitz, M.; Fischman, D.A. Zak, R. (Univ. of Chicago). *J. Biol. Chem.*; **250**: No. 11, 4278-4284(10 Jun 1975).

A calcium-activated factor (casein aAF) has been isolated and partially purified from the post-myofibrillar supernatant fraction of rabbit skeletal muscle. The 200-fold purified CaAF hydrolyzed denatured casein,[^{3}H]acetyl hemoglobin, and N-ethyl[^{3}H]maleimide-labeled α-actinin. The proteolytic activity has a pH optimum at 6.9 and is dependent on the presence of Ca^{2+} (optimum concentration, 10 mM). Digestion of isolated myofibrils with CaAF results in removal of Z-lines and in a parallel loss of a 90,000-dalton protein that has a mobility identical with that of α-actinin as determined by polyacrylamide gel electrophoresis. A protein with the properties of α-actinin (identcal electrophoretic mobility, and ability to accelerate the Mg^{2+}-activated ATPase of reconstituted actomyosin) was isolated from the supernatant of CaAF-treated myofibrils. The release of α-actinin from myofibrils by the calcium-activated neutral protease occurs in the absence of detectable change in the electrophoretic profiles of the other myofibrillar proteins, or in the ethylene glycol bis(β-aminoethyl ether)-N,N′ tetraacetic acid (EGTA) sensitivity of Mg^{2+}-activated ATPase. In contrast to the specific removal of Z-lines and of α-actinin by CaAF, trypsin treatment of myofibrils results in extensive degradation of myosin heavy chains and of the inhibitory component of troponin (TN-I), and in loss of EGTA sensitivity of myofibrillar ATPase.The degradation of TN-I and loss of EGTA sensitivity occur before the Z-line disappearance. (auth)

3937 Extraction of Renilla-type luciferin from the calcium-activated photoproteins aequorin, mnemiopsin, and berovin. Ward, W.W.; Cormier, M.J. (Univ. of Georgia, Athens). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 7, 2530-2534(Jul 1975).

Photoproteins, which emit light in an oxygen-independent intramolecular reaction initiated by calcium ions, have been isolated from several bioluminescent organisms, including the hydrozoan jellyfish Aequorea and the ctenophore Mnemiopsis. The system of a related anthozoan coelenterate, the sea pansy Renilla reniformis, however, is oxygen dependent, requiring two organic components, luciferin and luciferase. Previously published indirect evidence indicates that photoproteins may contain a Renilla-type luciferin. We have now extracted in high yield a Renilla-type luciferin from three photoproteins, aequorin (45 percent yield), mnemiopsin (98 percent yield), and berovin (85 percent yield). Photoprotein luciferin, released from the holoprotein by mercaptoethanol treatment and separated from apo-photoprotein by gel filtration, no longer responds to calcium but now requires luciferase and O_2 for light production. Photoprotein luciferin is identical to Renilla luciferin with respect to reaction kinetics and bioluminescence spectral distribution. In view of these results, the generally accepted hypothesis that the photoprotein chromophore is a protein-stabilized hydroperoxide of luciferin must be modified. We believe, instead, that the chromophore is free luciferin and that oxygen is bound as an oxygenated derivative of an amino-acid side chain of the protein. We propose the general term "coelenterate luciferin" to describe the light-producing chromophore from all bioluminescent coelenterates and ctenophores. (auth)

3938 Chromatin architecture: investigation of a subunit of chromatin by dark field electron microscopy. Langmore, J.P.; Wooley, J.C. (Univ. of Chicago). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 7, 2691-2695(Jul 1975).

Dark field scanning electron microscopy of unstained, unfixed samples of chromatin, histone-I-depleted chromatin, and nucleohistone has been used to identify an apparent subunit of chromatin, namely, a disk-shaped structure we term the unit particle, which is probably about 135 A wide and 50 A thick in the hydrated state. The unit particles are found at rather uniform intervals along thin DNA-like fibers. Histone I depletion leads to a bimodal distribution of these spacings. Our observations suggest that the unit particle consists of a loop of nucleoprotein, perhaps around a histone core. (auth)

3939 Donor properties of the three carbonyl groups of chlorophyll a: ab initio calculations and ^{13}C magnetic resonance studies. Shipman, L.L. (Argonne National Lab., IL); Janson, T.R.; Ray, G.J.; Katz, J.J. *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 8, 2873-2876(Aug 1975).

The relative donor properties of the three carbonyl groups of chlorophyll a have been studied theoretically by a series of ab initio molecular fragment, floating spherical Gaussian orbital, self-consistent field calculations on ethyl chlorophyllide a and experimentally through a ^{13}C magnetic resonance study on chlorophyll a. The approximate ground state electronic wavefunction of ethyl chlorophyllide a was perturbed by monopole and dipole point charges whose signs, magnitudes, and positions were chosen to mimic the coulombic interactions associated with carbonyl coordination to Mg. Because the polarizability of the ring V keto carbonyl binding site is substantially greater than that for the ester carbonyl binding sites, the ring V keto binding site binds with smallest binding energy for weak perturbations and with largest binding energy for strong perturbations. A comparison of ^{13}C magnetic resonance chemical shifts in chlorophyll a monomer and dimer provides new experimental evidence that the donor-acceptor interactions that bind the chlorophyll dimer together involve a substantial participation by the two ester carbonyl groups, and thus are in agreement with conclusions derived from the ab initio calculations. (auth)

3940 Visualization of a novel junction in bacteriophage lambda DNA. Valenzuela, M.S. (Brandeis Univ., Waltham, MA); Inman, R.B. *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 8, 3024-3028(Aug 1975).

At early times after infection of a recA derivative of Escherichia coli with λb221cI26red270a42 phage, a low but significant proportion of intracellular λ molecules show a novel junction. These junctions are also present, although in reduced numbers, in a lysate obtained at late times after infection of a recA$^+$ host with λcIIcIII phage. Fine structure and denaturation mapping analyses showed that these junctions occur at homologous positions and that they are compatible with the occurrence of a cross-strand exchange between λ DNA duplexes similar to the type proposed in most molecular models for genetic recombination. However, the results are also consistent with the structures expected if a replicating growing point undergoes branch migration. (auth)

3941 Stabilization of electron spin resonance probes for photosynthesis studies. Sun, A.S.; Calvin, M. (Univ. of California, Berkeley). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 8, 3107-3110(Aug 1975).

The major obstacle to the study of functional/structural interrelationships of spinach chloroplasts by using spin labels has been the rapid loss of the electron paramagnetic resonance (EPR) signals upon illumination with visible light. The present study demonstrates that the addition of ferredoxin and NADP$^+$ in the presence of N-tris(hydroxymethyl)methylglycine (Tricine) buffer at pH 7.1 or higher mitigates the rapid loss of Biradical X[N,N′-bis(1-oxyl-2,2,5,5-tetramethylpyrroline-3-carboxy)-1,2-diaminoethane] and Monoradical A (2,2,5,5-tetramethyl-3-carbamidpyrroline-1-oxyl). However, the 5-line EPR spectrum characteristic of Biradical X in aqueous solution was changed to a dominantly 3-line spectrum within a few minutes after illumination in the presence of ferredoxin and NADP$^+$. Analysis of the double integration of the first derivative EPR spectrum revealed no decrease in Biradical X concentration for more than 30 min of illumination. Our data suggest that Biradical X attaches to some soluble macromolecule(s) and that illumination of chloroplasts promotes such an attachment. (auth)

3942 Triplet state in bacterial photosynthesis: possible mechanisms of the primary photo-act. Thurnauer, M.C.; Katz, J.J.; Norris, J.R. (Argonne National Lab., IL). *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 9, 3270-3274(Sep 1975).

In vitro and in vivo triplet state electron paramagnetic resonance (epr) spectra of bacteriochlorophylls (Bchls) show important differences in (a) electron spin polarization (esp), and (b) zero field splitting (ZFS) parameters. The unusual esp and ZFS properties of the observed in vivo triplet state are best interpreted as arising from a short-lived radical pair precursor (not directly observable by epr) formed in or with the special pair of bacteriochlorophyll molecules involved in the primary photo-act. (auth)

3943 Analysis of oncornavirus RNA subunits by electron microscopy. Heine, U.I. (National Cancer Inst., Bethesda, MD); Weber, G.H.; Cottler-Fox, M.; Layard, M.W.; Stephenson, M.L.; Zamecnik, P.C. *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 9, 3716-3720(Sep 1975).

Subunits of oncornavirus (avian myeloblastosis virus) RNA were isolated from purified 60-70S viral RNA by heat dissociation. Molecules sedimenting at 35 S, assumed to be the major component of the viral genome, were visualized in the electron microscope and their lengths were statistically analyzed. The results indicate a rather heterogeneous population of molecules with five distinct, reproducible size groups, an observation that excludes the assumption of random degradation of the genome. In addition, molecules of 28 and 18S RNA, always present in oncornavirus RNA preparations, were examined with the same method. Some of these molecules possess secondary-structure regions similar to those characteristic for ribosomal RNA. (auth)

3944 Adenosine, AMP, cyclic AMP, theophylline and the action and production of erythropoietin. Schooley, J.C.; Mahlmann, L.J. (Univ. of California, Berkeley). *Proc. Soc. Exp. Biol. Med.;* **150**: No. 1, 215-219(Oct 1975).

Erythropoiesis, as measured by the uptake of ^{59}Fe into plethoric mice, is stimulated by adenosine, AMP, cyclic AMP, and dibutyryl cyclic AMP, but not by cytidine, its nucleotides or cyclic GMP. This stimulation is erythropoietin dependent, because it is prevented by anti-erythropoietin. Theophylline neither stimulates erythropoiesis nor potentiates the action of erythropoietin on bone marrow cells in plethoric mice. Theophylline does potentiate the production of erythropoietin in rats following a brief hypoxic exposure but does not cause a similar increase in mice. (auth)

3945 DNA replication in homogenates of physarum polycephalum. Brewer, E.N.; Ting, P. (Case Western Reserve Univ., Cleveland). *J. Cell. Physiol.;* **86**: No. 3, 459-470(Dec 1975).

Homogenates of Physarum polycephalum incorporate [^3H] dATP into nuclear DNA at an initial rate of approximately 15 percent of the in vivo rate. To attain this level of synthesis, cultures are homogenized in a medium containing Mg^{++}, EGTA, glucose and spermine. Incorporation is strongly stimulated by the addition of ATP and all four deoxyribonucleoside triphosphates to homogenates prior to incubation. Various inorganic cations other than Mg^{++} either do not affect synthesis or are inhibitory. Incorporation is inhibited by a nonionic detergent, Triton X-100. DNA synthesis in this cell-free nuclear system is similar in several respects to that which occurs in vivo: The rate of DNA synthesis in the intact organism at a given time in the mitotic cycle is reflected by the level of synthesis in homogenates prepared from cultures at that time of the cycle; DNA strands labeled in vitro exhibit alkaline sucrose density gradient sedimentation properties similar to those of daughter-strand DNA pulse-labeled in vivo; and Homogenates of cultures which were pre-treated with cycloheximide incorporate [^3H] dATP at about 60 percent of the level observed in homogenates of untreated controls. (auth)

3946 Monoanion inhibition and ^{35}Cl nuclear magnetic resonance studies of renal dipeptidase. Ferren, L.G.; Ward, R.L.; Campbell, B.J. (Univ. of Missouri, Columbia). *Biochemistry;* **14**: No. 24, 5280-5285(2 Dec 1975).

Kinetic analyses of monoanion inhibition and ^{35}Cl nuclear magnetic resonance at 5.88 MHz were employed to study monoanion interactions with the zinc metalloenzyme, renal dipeptidase. The enzyme-catalyzed hydrolysis of glycyldehydrophenylalanine exhibited competitive inhibition when the reaction rate was determined in the presence of the monovalent anions fluoride, chloride, bromide, iodide, azide, nitrate, or thiocyanate or upon the addition of the divalent anion, sulfate. Competitive inhibition was produced by these anions. Cyanide ion produced a much more effective inhibition of renal dipeptidase than the other monoanions, and it was shown that two cyanide ions were bound per enzyme molecule. Complete dissociation of this group (approximately pH 8.4) eliminates the inhibitory effect of anions. The ^{35}Cl line broadening produced by renal dipeptidase in 0.5 M NaCl solutions was 100 times more effective than that produced by equivalent concentrations of aquozinc(II). The line broadening was dependent upon the concentration of the metalloenzyme and independent of the frequency of the exciting radiation. When zinc ion was removed from the metalloenzyme by dialysis or when chloride was titrated from the metalloenzyme by cyanide, line broadening was decreased. The ^{35}Cl line broadening produced by renal dipeptidase was shown to decrease with increasing pH through the range pH 5.8 to 10.8. This line-width variation with pH appeared to result from the titration of a site on the metalloprotein with an approximate pK of 7.4. Temperature studies of ^{35}Cl line broadening by the metalloenzyme in the presence of chloride and cyanide inhibitors suggest that the fast exchange process pertains and that the dominant relaxation mechanism is quadrupolar in nature. (auth)

TRACER TECHNIQUES

3947 (LA-UR—75-1985) **Biosynthetic and biophysical information from ^{13}C-^{13}C multiplets by ^{13}C nuclear magnetic resonance.** London, R.E.; Kollman, V.H.; Mueller, D.D.; Matwiyoff, N.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 34p. (CONF-751027—3). Dep. NTIS $5.00.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

^{13}C enriched molecules exhibit multiplets due to ^{13}C-^{13}C scalar coupling. Although generally viewed as a complicating factor, these multiplets can be used in a variety of ways to obtain different types of information. Biosynthetic applications are based on the fact that the relative multiplet intensities are related quantitatively to the percent enrichment of the carbons. Thus, ^{13}C enrichment during the course of a biosynthetic experiment can be monitored by an analysis of the ^{13}C-^{13}C multiplet intensities. In addition, multiplet peaks provide a way of measuring a correlation in the ^{13}C labeling of scalar coupled carbons. Biophysical measurements are based on the ^{13}C-^{13}C dipolar coupling which can provide a significant contribution to the relaxation of non-protonated carbons. This technique can be particularly useful for studying internal rotation which will affect the ratio of the ^{13}C-^{1}H to the ^{13}C-^{13}C dipolar coupling. Examples of each type of application presented include; biosynthetic studies of the photosynthetic fixation of $^{13}CO_2$ into 2-hydroxy-1-(hydroxymethylethyl) α-D-galactopyranoside [galactosyl glycerol] by species of the marine red alga, Gigartina. Algal samples were then taken at various times after the initial exposure to $^{13}CO_2$ and the galactosyl glycerol was extracted. Nmr and mass spectrometric measurements indicate that the galactosyl glycerol consists of a pool of unlabeled material and a pool of newly synthesized material, the labeling of which increases as time progresses. Spin lattice relaxation and nuclear Overhauser enhancement measurements of ^{13}C-^{13}C multiplets of 6-phosphogluconate. Measurements made in D_2O on the carboxyl carbon resonances were compared with calculated T_1 and NOE values for singlet and doublet lines. The results indicate anisotropic rotation of the molecule. (auth)

3948 Isolation of newly synthesized myosin filaments from skeletal muscle homogenates and myofibrils. Etlinger, J.D.; Zak, R.; Fischman, D.A.; Rabinowitz, M. (Univ. of Chicago). *Nature (London);* **255**: No. 5505, 259-261(15 May 1975).

A procedure is described for isolation of newly synthesized myosin filaments from skeletal muscle homogenates and myofibrils of rats. To investigate the significance of the easily releasable filaments, rats were injected with tritiated leucine. At intervals the animals were killed and the isolated filaments were prepared. The residual undispersed myofibrils were also prepared. The specific activity of the myosin heavy chain in the filament fractions was higher than that obtained from residual myofibrils. (HLW)

CYTOLOGY

3949 (LA-UR—75-1722) **Sequential biochemical events in the cell cycle.** Tobey, R.A.; Walters, R.A.; Hohmann, P.G.; Hildebrand, C.E.; Gurley, L.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 24p. (CONF-750953—1). Dep. NTIS $4.25.

From International congress of cell culture and its application; Birmingham, Alabama, USA (21 Sep 1975).

The detection of specific sequences of biochemical processes as cells prepare for DNA replication and division suggests the temporally ordered expression of genetic information during the cell cycle. Although little is known about the underlying regulatory mechanisms, it has been suggested that changes in chromatin structure may be involved in control of cycle-specific events. One possible avenue for altering chromatin structure involves the reversible modification of histones, consequently, cultured CHO cells were used to examine the relationship between phosphorylation of histones and changes in the structure of chromatin during the cell cycle. Preliminary findings are reported. (CH)

3950 (LA-UR—75-1727) **Multiangle light-scattering methods for mammalian cell detection and identification.** Mullaney, P.F.; Crowell, J.M.; Salzman, G.C.; Martin, J.C.; Hansen, K.M.; Goad, C.A.; Ingram, M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 27p. (CONF-750957—2). Dep. NTIS $4.50.

From 2. international symposium on pulse cytophotometry; Munster, F.R. Germany (17 Sep 1975).

In special cases where the impulse cytophotometric method is used for diagnostic purposes the instrument will recognize cells as abnormal on its own terms (i.e., quantitative fluorescence). In any diagnostic situation, it is absolutely necessary that the instrument results be verified. For this reason, cell-sorting instruments to physically isolate the abnormal cells for examination by cytotechnologists and pathologists have been developed. It is necessary that the fluorescent staining technique used for instrumental analysis be compatible with the subsequent staining required for visual examination. Use of light-scattering techniques offers an attractive alternative to these difficulties, since they do not necessarily require that the cells be stained. Therefore, cells can remain viable for other purposes, and essentially virgin material can be recovered for Papanicolaou or other staining for cytology purposes. Flow-systems light-scattering techniques are described and preliminary findings are discussed. (CH)

3951 (LA-UR—75-1741) **Comparison of quantitative fluorescent staining methods for flow-system analysis of DNA,**

protein, and nuclear-to-cytoplasmic size in cultured cells, tumor cells, and human gynecological specimens. Crissman, H.A.; Steinkamp, J.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-eng-36. 31p. (CONF-750957—1). Dep. NTIS $4.75.

From 2. international symposium on pulse cytophotometry; Munster, F.R. Germany (17 Sep 1975).

Three groups of reagents having different mechanisms of action for DNA binding were used for quantitative fluorescent staining and analysis of cellular DNA. The reagents used included the fluorescent antitumor antibiotics mithramycin, chromomycin A_3, and olivomycin; Feulgen dyes acriflavine and flavophosphine N; and intercalating dyes ethidium bromide and propidium iodide. Propidium iodide (PI) was also used in combination with fluorescein isothiocyanate (FITC) to stain both cellular DNA and protein, respectively. Multiparameter analysis of PI/FITC-stained cells provided a direct correlation of DNA and protein for cells in all stages of the cell cycle. Nuclear-to-cytoplasmic (N/C) ratio determinations were also performed on PI/FITC-stained cells by analysis of the time duration of the red (DNA) and green (protein) fluorescence signals from each cell. A simple and rapid alternative method which was also used for N/C ratio measurements involved analysis of both the time duration of the nuclear (N) fluorescence of mithramycin-stained cells and the duration of the cellular light-scatter signal (C). These staining and analysis techniques provide alternative methods for directly determining the quantitative relationship between cellular DNA and protein in cultured cells, tumor cells, and human gynecological specimens. (auth)

3952 (LA-UR—75-2056) **Arrested and cycling CHO cells as a kinetic model: studies with adriamycin.** Tobey, R.A.; Crissman, H.A.; Oka, M.S. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 29p. (CONF-751129—1). Dep. NTIS $5.00.

From Conference on cell kinetics and cancer chemotheraphy; Annapolis, Maryland, USA (4 Nov 1975).

Adriamycin was examined for effects on survival and cell-cycle progression in exponentially growing (cycling) populations of line CHO Chinese hamster cells and in isoleucine-deficient G_1-arrested (non-cycling) cells. (CH)

3953 (UCRL—52000-75-10, pp 14-19) **Flow microfluorometry: analyzing sperm DNA content.** Oct 1975.

In Lawrence Livermore Laboratory energy and technology review.

Flow microfluorometry has become a key tool in biomedical research because it allows cell analysis at extremely high rates (100,000 cells per minute) with statistical precision and sensitivity. One application of the LLL bicolor flow microfluorometer is to detect variability in the DNA content among individual mollusk and mammalian sperm. DNA variability should be a sensitive indicator of mutagenic events in these cells. Ultimately, we hope to identify and assess the effects on man and his environment of the chemical byproducts from various energy-production streams. (auth)

3954 (UCRL—77207) **Markovian analysis of cervical cell images.** Pressman, N.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Sep 1975. 28p. (CONF-750680—1). Dep. NTIS $4.50.

From 4. engineering foundation conference on automatic cytology; Pacific Grove, California, USA (8 Jun 1975).

Markovian analysis is a method to measure optical texture based on gray-level transition probabilities in digitized images. Experiments are described that investigate the classification performance of parameters generated by Markovian analysis. Results using Markov texture parameters show that the selection of a Markov step size strongly affects classification error rates and the number of parameters required to achieve the maximum correct classification rates. Markov texture parameters are shown to achieve high rates of correct classification in discriminating images of normal form abnormal cervical cell nuclei. (auth)

3955 Nuclear changes during mammalian spermiogenesis. Gledhill, B.L. (Univ. of California, Livermore). *Biol. J. Linn. Soc.*; **7**: 215-226(1975).

This article reviews the development of knowledge of the nuclear changes that occur during mammalian spermiogenesis. Emphasis is placed on biophysical and cytochemical research in the last decade. Although direct evidence may not be available at present, an attempt is made to develop a unifying theme. Only meagre information is available on the regulatory mechanisms associated with the specific events of biological importance. This article is focused on selected structural and chemical properties of the nuclear chromatin of male gametes relevant to an understanding of these underlying mechanisms. To this end, particular emphasis is placed on the use of molecular probes such as fluorochrome dyes, together with ultraviolet and visible-light cytophotometry of fixed cells from a variety of mammals. (auth)

3956 High-speed quantitative karyotyping by flow microfluorometry. Gray, J.W.; Carrano, A.V.; Moore, D.H. II; Steinmetz, L.L.; Minkler, J.; Mayall, B.H.; Mendelsohn, M.L.; Van Dilla, M.A. (Univ. of California, Livermore). *Clin. Chem.*; **21**: No. 9, 1258-1262(1975).

A new flow-system technique is described for high-speed quantitative karyotyping. Metaphase chromosomes are isolated from cells, stained with a DNA-specific fluorochrome, and individually measured for stain content at rates up to 10^3/min in a flow microfluorometer. The resulting distribution contains quantitative information about the relative frequency of occurrence and the chromosomal DNA content of the measured chromosomes. Such analyses of Chinese hamster chromosomes are in good agreement with independent results from scanning cytophotometry and with cytogenetic observations of the banded chromosomes. Analyses of two karyotypically different clones of Chinese hamster M3-1 lines provide the quantitative characterization of two stable translocations. Initial data on human chromosomes are presented and agree well with results of scanning cytophotometry and suggest potential clinical applications as preparative and instrumental techniques improve. (auth)

3957 Sea urchin blastula: extent of cellular determination. Timourian, H.; Watchmaker, G. (Univ. of California, Livermore). *Amer. Zool.*; **15**: 607-627(1975).

The extent of cellular determination at the blastula stage of sea urchins has been investigated by using as parameters the morphological differentiation and cellular interactions of dissociated blastula cells under conditions that either promote or discourage their reaggregation and reconstitution into embryos. The dissociated blastula cells have the capacity to differentiate into at least three different specific cell types that occur in the normally developing sea urchin embryo. Of these, ciliated epithelium is known to originate in the animal half, and spindle-shaped cells and polyfilamentous cells are of mesenchymal origin and are derived from the vegetal half. The formation of ciliated epithelium and blastulation requires calcium and hyalin; the cellular differentiation and interactions of the mesenchymal cells do not. This basic difference in calcium requirement is explored in terms of differential hyalin synthesis or secretion by the cells at either equatorial half of the embryo. The animalizing effect of zinc and the vegetalizing effect of lithium can be explained in part by their enhancement and reduction, respectively, of hyalin gelation by calcium. Literature relating to other basic differences along the animal-vegetal axis of the embryo is appraised. These differences include the use and the assembly of microtubule protein and quantitative RNA synthesis during both the cleavage and blastula stages. (auth)

3958 Seasonal mitotic activity and wound healing in a teleost (Opsanus tau) ocular lens. Reddan, J.; Harding, C.; Harding, D.; Weinsieder, A.; Unakar, N.; Shapiro, R.; Mathews, C. (Oakland Univ., Rochester, MI). *Experientia*; **31**: No. 9, 1026-1028(15 Sep 1975).

The toadfish lens epithelium is essentially amitotic from January to May. From June to August mitotic activity is noted. The onset of proliferation approximately corresponds to the time of year when the fish enter the shallow water to spawn. The epithelial mitotic response to needle injury is not propagated in a wave-like manner from the site of insult. (auth)

3959 Improved diffusion chamber (DC) for culture of hematopoietic cells. Carsten, A.L.; Chanana, A.D.; Chikkappa, G.; Cronkite, E.P.; Oehl, S. (Brookhaven National Lab., Upton, NY). *Proc. Soc. Exp. Biol. Med.*; **150**: No. 1, 107-109(Oct 1975).

A DC with Nuclepore filter wall has been described. Recovery of in vitro incubated human nucleated peripheral blood cells and in vivo growth of mouse bone marrow cells in intraperitoneally implanted DCs were improved when compared to the growth obtained in the more commonly used Millipore filter chambers. (auth)

3960 Initiation of 3T3 fibroblast cell division by epidermal growth factor. Rose, S.P.; Pruss, R.M.; Herschman, H.R. (Univ. of California, Los Angeles). *J. Cell. Physiol.*; **86**: No. 3, 593-598(Dec 1975).

Epidermal Growth Factor (EGF) at concentrations of 10^{-9} to 10^{-10} M initiates cell division in both confluent and low density non-dividing 3T3 cells. Four days after addition of EGF to confluent or low density non-dividing 3T3 cells there is a 2- and 5-fold increase, respectively, in cell number. (auth)

TRACER TECHNIQUES

3961 (LA-UR—75-1983) **High-level ^{13}C-enrichment of random and synchronous populations of Chlamydomonas reinhardii.** Price, R.L.; Crissman, H.A.; Martin, J.C.; Kollman, V.H. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 38p. (CONF-751027—6). Dep. NTIS $4.75.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

The alga Chlamydomonas reinhardii was grown in suspension culture at high levels of ^{13}C-enrichment (98 mol percent) both in synchronous and random populations for the purpose of investigating possible macro- and ultrastructural changes in the cell as induced by essentially total carbon replacement. The algae, grown in spinner flasks, were analyzed using a newly developed multiparameter flow-system technique applied to characterizing various algal genera. The versatility of this technique provides for measuring and processing several cell characteristics simultaneously and separating cells according to selected combinations of parameters. In these studies, cell volume (by Coulter aperture) and DNA and chlorophyll content were determined simultaneously. Cell ultrastructure was examined at various levels of isotope enrichment and time periods by electron microscopy. The data presented for synchronous growth of this organism demonstrate the absence of biological effects (considering the parameters measured) due to the almost total replacement of cellular ^{12}C with ^{13}C. Interpretational problems encountered when looking for biological effects on random populations are discussed. (auth)

3962 **Rapid phytohemagglutinin induced alteration in lymphocyte potassium permeability.** Segel, G.B.; Hollander, M.M.; Gordon, B.R.; Klemperer, M.R.; Lichtman, M.A. (Univ. of Rochester, NY). *J. Cell. Physiol.*; **86**: No. 2, 327-335(Oct 1975).

The exposure of rat and human lymphoid cells to mitogenic concentrations of phytohemagglutinin resulted in an apparent decrease in cellular K^+ without a significant change in cellular Na^+ when the cells were washed with isotonic Hepes buffered choline chloride prior to cation determination. The apparent reduction in total cellular Na^+ plus K^+ concentration, however, was not accompanied by a change in cell volume. We inferred that the constant cell volume could occur only if the lost intracellular K^+ was exchanged for an external cation during the washing procedure used to prepare cells for Na^+ and K^+ measurement. This inference was supported by the quantitative recovery of lost cellular K^+ in the choline chloride washing solution and the demonstration that a comparable proportion of $^{86}Rb^+$ (K^+ analogue) $^{42}K^+$ was lost from prelabelled cells during choline washing. Use of medium 199 with Hanks salts, 150 mM NaCl, or 100 mM $MgCl_2$ as the washing solution did not prevent K^+ exchange although exchange was less in the presence of $MgCl_2$. These findings indicate that phytohemagglutinin produces a rapid alteration in lymphocyte plasma membranes so as to allow abnormal K^+ exchange. This observation is of importance because investigators who measure intracellular solutes in phytohemagglutinin-treated lymphocytes must consider the possibility of loss during preparative washes. Also, changes in membrane permeability following phytohemagglutinin treatment may modulate mitogenesis and/or permit the transmission of chemical messages between cells. (auth)

GENETICS

3963 (COO—2013-23) **Congenital malformations and other disorders: the influence of genetic and nongenetic factors. Final report, January 1, 1974—June 30, 1975.** Woolf, C.M. (Arizona State Univ., Tempe (USA)). 1975. Contract E(11-1)-2013. 61p. Dep. NTIS $5.50.

Data are presented from a 15-year study of the etiological role of genetic and specific nongenetic factors for certain congenital malformations in man. A list is included of 20 papers published as a result of this research program. Human populations in the US were studied for genetic and nongenetic variables related to the incidence of albinism (among Indian tribes), cleft lip and palate, polydactyly, and congenital hip disease. (CH)

3964 (UCD—34P-200X2) **Genetic structure of natural populations. Progress report.** Ayala, F.J. (California Univ., Davis (USA). Dept. of Genetics). 20 Aug 1975. Contract AT(04-3)-34. 12p. Dep. NTIS $4.00.

Progress is reported on the following research projects: genetic load in natural population of Drosophila melanogaster; protein polymorphisms and natural selection; genetic variation at the molecular level; enzyme activity and gene regulation; and genetic variation in marine invertebrates and environmental stability. (HLW)

3965 **Dose—response relationship for ethyl methanesulfonate-induced mutations at the hypoxanthine—guanine phosphoribosyl transferase locus in Chinese hamster ovary cells.** Hsie, A.W.; Brimer, P.A.; Mitchell, T.J.; Gosslee, D.G. (Oak Ridge National Lab., TN). *Somatic Cell Genet.*; 1: No. 3, 247-261(1975).

From 13. annual somatic cell genetics conference; St. Thomas, Virgin Islands (12 Dec 1974).

The frequency of ethyl methanesulfonate (EMS)-induced mutations to 6-thioguanine resistance in a Chinese hamster ovary cell clone K_1BH_4 was studied as many EMS doses including the minimally lethal range (0-100μg/ml) as well as the exponential killing portion (100-800 μg/ml) of the survival curve. The mutation frequency increases approximately in proportion with increasing EMS concentration at a fixed treatment time. The pooled data for the observed mutation frequency, f(X), as a function of EMS dose X, is adequately described by a linear function $f(X) = 10^{-6}(8.73 + 3.45\,X)$, where 0 is less than or equal to X is less than or equal to 800 μg/ml. One interpretation of the linear dose-response is that, as a result of EMS treatment, ethylation of cellular constituents occurs, which is directly responsible for the mutation. Biochemical analyses demonstrate that most of the randomly isolated 6-thioguanine-resistant variants possess a highly reduced or undetectable level of HGPRT activity suggesting that the EMS-induced mutations to 6-thioguanine resistance affect primarily, if not exclusively, the HGPRT locus. (auth)

3966 **Sequence homology of the mitochondrial leucyl-tRNA cistron in different organisms.** Jakovcic, S.; Casey, J.; Rabinowitz, M. (Univ. of Chicago). *Biochemistry;* **14**: No. 10, 2037-2042(1975).

Sequence divergence of the mitochondrial leucyl-tRNA cistron in several eukaryotes has been examined by RNA-DNA hybridization. Rat mitochondrial leucyl-tRNA was hydridized with rat, mouse, guinea pig, monkey, chicken, and yeast mitochondrial DNAs (mtDNA) immobilized on filters. Hybridization was carried out in 50 percent formamide (T/sub m/ -12°) or in 20 percent formamide (T/sub m/-21°). Melting profiles of the hybrides were obtained for evaluation of the extent of base sequence mismatching. Under the more stringent hybridization conditions (50 percent formamide, T/sub m/ - 12°), only mouse and guinea pig mtDNAs hybridized with rat mitochondrial leucyl-tRNA. The T/sub m/'s of the heterohybrids were depressed by 2 and 9°, respectively. Under less stringent hybridization conditions (T/sub m/- 21°), monkey mtDNA also hybridized, and the T/sub m/ was depressed by about 15°. Chicken and yeast mtDNAs did not form specific hybrids with rat mitochondrial leucyl-tRNA under these hybridization conditions. Mitochondrial leucyl-tRNA sequences in different eukaryotes appear to be conserved to a less extent than cytoplasmic rRNA, 5S RNA, or hemoglobin mRNA sequences. (auth)

3967 **Mechanism of suppression in Drosophila. III. Phenol oxidase activity and the speck locus.** Warner, C.K.; Grell, E.H.; Jacobson, K.B. (Oak Ridge National Lab., TN). *Biochem. Genet.*; **13**: No. 5/6, 353-356(1975).

A marked decrease in the amount of the A_2 component of phenol oxidase occurs in the speck locus of Drosophila melanogaster. The amount of A_2 in speck is restored to a normal amount in the presence of the suppressor mutant, su(s)^2. (auth)

3968 **Mutagenicity of chloroacetaldehyde, a possible metabolic product of 1,2-dichloroethane (ethylene dichloride), chloroethanol (ethylene chlorohydrin), vinyl chloride, and cyclophosphamide.** McCann, J. (Univ. of California, Berkeley); Simmon, V.; Streitwieser, D.; Ames, B.N. *Proc. Natl. Acad. Sci. U.S.A.*; **72**: No. 8, 3190-3193(Aug 1975).

We have previously described a very sensitive and efficient bacterial test designed to detect chemical carcinogens as mutagens. Chloroacetaldehyde is mutagenic in this system and is of interest because it is a possible metabolite in mammals of the large volume industrial chemicals 1,2-dichloroethane (ethylene dichloride)(3.5 billion kg/yr, U.S.) and vinyl chloride (2.5 bilion kg/yr, U.S.), and of the antineoplastic agent cyclophosphamide. Chloroacetaldehyde reverts a new Salmonella bacterial tester strain (TA100). Chloroacetaldehyde is shown to be hundreds of times more effective in reversion of TA100 than is chloroethanol (ethylene chlorohydrin), a known metabolic precursor of chloroacetaldehyde and a possible metabolite of dichloroethane and vinyl chloride, or than vinyl chloride, which is itself mutagenic for TA100. Chloroethanol is shown to be activated by rat (or human) liver homogenates to a more highly mutagenic form with reversion properties similar to chloroacetaldehyde. Reversion properties of cyclophosphamide after in vitro metabolic activation suggest that chloroacetaldehyde is not the active mutagenic form of this antineoplastic drug. (auth)

3969 **Genetic drift in clines which are maintained by migration and natural selection.** Felsenstein, J. (Univ. of Washington, Seattle). *Genetics;* **81**: No. 1, 191-207(Sep 1975).

Genetic drift will cause a migration-selection cline to wobble about its expected position. A rough linear approximation is developed, valid when local populations are large. This is used to calculate effects of genetic drift on clines in a stepping-stone model with abrupt and with gradual changes of selection coefficients at a single haploid locus. Among the quantities calculated are measures of slope, standardized variation of gene frequencies around their expected values, and correlation among neighboring populations with respect to deviations from the expected gene frequencies. These quantities appear to be primarily functions of Ns and Nm for a given pattern of selection. Computer simulation gives rough confirmation of these results. Standardized variances of gene frequencies and correlation of neighbors differ along the cline in the case of smooth changes in selection. In no case is pathological behavior of gene frequency deviations found near the boundaries of selective regions. Local behavior of gene frequencies of nearby colonies is approximately predicted by a simple adaptation of the stepping-stone theory of KIMURA and WEISS. Approximate measures of the lateral variation of the midpoint of a cline and the probability of non-monotonicity are also calculated and discussed. (auth)

3970 das mutation in bacteriophage T4D does not suppress an amber mutation in T4 gene 59. Wiberg, J.S.; Swanson, R.S. (Univ. of Rochester, NY). *J. Virol.*; **16**: No. 5, 1348-1350(Nov 1975).

Mutations termed das were isolated originally as partial suppressors of mutants in phage T4 genes 46 and 47. Since mutants in genes 46,47, and 59 exhibit both an early arrest of phage DNA synthesis and the loss of this arrest in the presence of chloramphenicol or of mutations in T4 genes 33 and 55, we asked whether a das mutation can also suppress a gene 59 mutant. We find that it cannot--either at the level of phage production or DNA synthesis. (auth)

METABOLISM

3971 (BNL—20238) **Skeletal and lean body mass in alcoholics with and without cirrhosis.** Roginsky, M.S.; Zanzi, I.; Cohn, S. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 9p. (CONF-750557—2). Dep. NTIS $4.00.

From 11. European symposium on calcified tissues; Elsinore, Denmark (25 May 1975).

A decrease in bone mass has been reported in chronic alcoholics and in patients with cirrhosis. Although this decrease has been attributed to osteoporosis, the recent discovery of the importance of the liver in the metabolic transformation of vitamin D makes increasingly possible a role for vitamin D deficiency in this effect of alcohol and liver disease on the bone. Results are reported from a study undertaken to evaluate most precisely the total bone mass in two groups of alcoholic subjects, one with and the other without Laennec's cirrhosis. This skeletal mass was determined by the measurement of total body calcium (TBCa) using total body neutron activation analysis (TBNAA) by bone mineral content (BMC) of the radius, using the photon absorption technique. Lean body mass, which is proportional to total body potassium (TBK), was estimated from the measurement of ^{40}K by whole-body counting. In order to compare individual values of TBK or TBCa, it was necessary that the absolute values of these measurements be normalized for the variables of age, sex, and body size. Previously developed algorithms were used to predict the expected TBCa (Ca/sub p/) and expected TBK (K/sub p/). The relationship of the observed to the predicted values gave a figure we call the calcium ratio (TBCa/Ca/sub p/) and potassium ratio (TBK/K/sub p/), respectively. (auth)

3972 (BNWL-SA—5449) **Chemical changes in arsenic following ingestion by man.** Crecelius, E.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 11p. (CONF-750985—2). Dep. NTIS $4.50.

From 15. Hanford life sciences symposium; Richland, Washington, USA (25 Sep 1975).

The concentrations of four chemical forms of arsenic in human urine were observed with time after arsenite-rich wine was ingested. Approximately 10 percent of the arsenite ingested was excreted as arsenite but the majority of the arsenite was methylated to methylarsonic acid and dimethylarsinic acid and excreted. The apparent biological half-lives were on the order of 10 hours for arsenite and 30 hours for the methylated arsenic compounds. Within 3 days after ingestion 80 percent of the arsenic ingested had been excreted in the urine. (auth)

3973 (LBL—4264) **Estimation of the dynamical parameters of the Calvin photosynthesis cycle, optimization, and III conditioned inverse problems.** Milstein, J. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 254p. Dep. NTIS $10.00.

Thesis.

This thesis is concerned with the determination of kinetic parameters of the Calvin photosynthesis cycle and the numerical tools required. A mathematical model with seventeen non-linear ordinary differential equations describing this cycle is presented; its unknown parameters are to be determined using data from observations of the state variables and an optimization technique developed herein. This method for parameter identification involves a nonlinear optimization algorithm, first developed by Hans Bremermann, a computer routine for numerical integration of stiff systems and an error analysis technique, based on a method of Rosenbrook and Storey which was implemented and tested by Joel Swartz. Bremermann's optimization algorithm is tested and compared to other techniques frequently used on optimization and root-finding problems. Finally, in order to test both the mathematical model and parameter identification technique, an arbitrary choice of parameter-values was designated as the correct or exact parameter values and the technique was implemented using simulated observational data. (auth)

3974 Age-related refractoriness of PHA-induced lymphocyte transformation. I. Comparable sensitivity of spleen cells from young and old mice to culture conditions. Hung, C.Y.; Perkins, E.H.; Yang, W.K. (Univ. of Tennessee, Knoxville). *Mech. Ageing Dev.*; **4**: 29-39(1975).

The decline of phytohemagglutinin (PHA) responsiveness of spleen cells from aged mice was studied in an effort to determine the nature of the depressed PHA reactivity. The reduced response of DNA synthesis (thymidine incorporation) to PHA stimulation could not be attributed to a decreased viability of spleen lymphocytes from old mice in in vitro culture conditions, to different PHA dose requirements, or to longer periods of culture time for old mouse spleen cells to reach maximal activity. Culture of cells for 24-48 h prior to addition of PHA gave patterns of thymidine incorporation similar to those of freshly prepared spleen cells. The elimination of red blood cells by a brief hypotonic shock significantly increased thymidine incorporation in spleen lymphocytes from both young and old mice. (auth)

3975 N-glycosidase activity in extracts of Bacillus subtilis and its inhibition after infection with bacteriophage PBS2. Friedberg, E.C.; Ganesan, A.K.; Minton, K. (Stanford Univ., CA). *J. Virol.*; **16**: No. 2, 315-321(Aug 1955).

We have detected in crude extracts of Bacillus subtilis an N-glycosidase activity which catalyzes the release of free uracil from DNA of the subtilis phage PBS2 labeled with [^3H]uridine. This DNA contains deoxyuridine instead of thymidine. The enzyme is active in the presence of 1.0 mM EDTA and under these conditions Escherichia coli or T7 DNA labeled with [^3H]thymidine is not degraded to labeled acid-soluble products. The activity resembles an N-glycosidase from E. coli which releases free uracil from DNA containing deaminated cytosine residues. Both enzymes in crude extracts are active in the presence of EDTA, do not require dialyzable co-factors, and have the same pH optimum. They differ in that the enzyme from E. coli is more sensitive to heat, sulfhydryl reagents, and salt. The enzyme from B. subtilis is inactive on DNA containing 5-bromouracil or hydroxymethyluracil. Extracts of PBS2-infected B.subtilis lose the N-glycosidase activity within 4 min after infection and contain a factor that inhibits the N-glycosidase activity in extracts of uninfected cells in vitro. (auth)

3976 Low and variable critical concentrations of calcium in plant tissues. Wallace, A.; Soufi, S.M. (Univ. of California, Los Angles). *Commun. Soil Sci. Plant Anal.*; **6**: No. 3, 331-337(1975).

Calcium seems to be required by higher plants (and in parts of higher plants) in variable concentrations and much confusion exists about plant requirements of it. When most heavy metal concentrations are low, the calcium requirement in plants can also be low. Levels of calcium of 800 or less and up to 2000 ppm of dry weight are adequate under some conditions. Even though the requirement may be low, these levels are not much above critical concentrations and deficiency problems are easily encountered. Some calcium deficiency problems seem to be related to this phenomenon. (auth)

3977 Flash kinetics and light intensity dependence of oxygen evolution in the blue-green alga Anacystis nidulans. Ley, A.C.; Babcock, G.T.; Sauer, K. (Univ. of California, Berkeley). *Biochim. Biophys. Acta*; **387**: 379-387(1975).

Patterns of oxygen evolution in flashing light for the blue-green alga Anacystis nidulans are comp red with those for broken spinach chloroplasts and whole cells of the green alga Chlorella pyrenoidosa. The oscillations of oxygen yield with flash number that occur in both Anacystis and Chlorella, display a greater degree of damping than do those of isolated spinach chloroplasts. The increase in damping results from a two- to threefold increase in the fraction (α) of reaction centers missed by a flash. The in-

crease in α cannot be explained by non-saturating flash intensities or by the dark reduction of the oxidized intermediates formed by the flash. Anaerobic conditions markedly increase α in Anacystis and Chlorella but have no effect on α in broken spinach chloroplasts. The results signify that the mechanism of charge separation and water oxidation involved in all three organisms is the same, but that the pool of secondary electron acceptors between Photosystem II and Photosystem I is more reduced in the dark, in the algal cells, than in the isolated spinach chloroplasts. Oxygen evolution in flashing light for Anacystis and Chlorella show light saturation curves for the oxygen yield of the third flash (Y_3) that differ markedly from those of the steady-state flashes (Y/sub s/). In experiments in which all flashes are uniformly attenuated, y_3 requires nearly twice as much light as Y/sub s/ to reach half-saturation. Under these conditions Y_3 has a sigmoidal dependence on intensity, while that of Y/sub s/ is hyperbolic. These differences depend on the number of flashes attenuated. When any one of the first three flashes is attenuated, the variation of Y_3 with intensity resembles that of Y/sub s/. When two of the first three flashes are attenuated, Y_3 is intermediate in shape between the two extremes. (auth)

3978 Poly(rA):oligo(dT)-directed DNA polymerase activity in carcinogen induced rat mammary tumors and in normal tissues. Libertini, L.J.; Adams, J. (Univ. of California, Berkeley). *Biochem. Biophys. Res. Commun.*; **64**: No. 1, 136-143(1975).

Mammary tumors induced in Sprague-Dawley rats by the carcinogen 7,12-dimethylbenz(a)anthracene contain a DNA polymerse similar to that found in RNA tumor viruses. It has a molecular weight of 105,000 daltons and is active on the synthetic templates poly(rA): oligo(dT) and poly(rC):-oligo(dG) but is inactive on poly(dA):oligo(dT). This polymerase may be purified more than 300 fold with a 25 percent yield by ammonium sulfate precipitation, phosphocellulose chromatography and hydroxyapatite chromatography. A similar polymerase is also found in lactating normal rat mammary tissues. (auth)

3979 Identification of phthalic acid esters in the tissues of cyprinodont fish and their activity as heartrate depressors. Pfuderer, P.; Janzen, S.; Rainey, W.T. Jr. (Oak Ridge National Lab., TN). *Environ. Res.*; **9**: 215-223(1975).

Two substances isolated from carp liver have been identified as dioctyl phthalate and butylbenzyl phthalate. When partially purified from fish liver by two-step column chromatography, these esters exhibited heartrate depressor activity. A pure sample of dioctyl phthalate was not active in the assay, however, while a sample of butylbenzyl phthalate containing 1.5 percent dibutyl phthalate was slightly active, probably due to the dibutyl phthalate it contained. A third phthalate ester, dibutyl phthalate, has also been found in carp liver, in lower concentrations than the other esters, and is a heartrate depressor. Pure samples of dibutyl phthalate remained active at levels of 5 ppM and higher. We are forced to conclude either that traces of a compound which complexes or enhances the activity of dioctyl and butylbenzyl phthalate is responsible for their activity, or that traces of a more active compound are present with them. Dioctyl phthalate was also shown to form complexes in ethanol with fish lipids, presumably with fish di- and triglycerides. (auth)

3980 Quantitative measurement of SV40 T-antigen production. Horan, M.; Horan, P.K.; Williams, C.A. (Los Alamos Scientific Lab., NM). *Exp. Cell Res.*; **91**: 247-252(1975).

African green monkey cells (CV-1) were infected with SV40 virus at high multiplicities of infection (MOI), and the production of T-antigen was studied. A new instrumentation, flow microfluorometry, coupled with indirect immunofluorescence permitted quantitative evaluation of this antigen. Optimum conditions were determined for antibody excess. Antigen production was not detected for the first 6 h post-infection. The value of this technology is discussed in relation to quantitative evaluation of expression of cellular antigens. (auth)

3981 Early alterations in plasma esterases with associated pathology following oral administration of diethylnitrosamine and butylated hydroxytoluene singly or in combination. Tyndall, R.L.; Colyer, S.; Clapp, N. (Oak Ridge National Lab., TN). *J. Natl. Cancer Inst.*; **16**: 184-191(1975).

Plasma esterase changes are apparent in BALB/c mice within 3 weeks after feeding them laboratory chow with 0.75 percent of the antioxidant BHT added. Other esterase changes, different from those in BHT-treated animals, are also apparent in plasma of mice during exposure to the carcinogen DENA. Interference with these DENA esterase alterations is apparent in plasma of mice treated concomitantly with both DENA and BHT. Esterase changes resulting from either the carcinogen or antioxidant exposure precede the overt histologically detected changes induced by these compounds. The early esterase changes and subsequent tumorigenesis resulting from DENA exposure are more severe in female mice. Some of the esterases altered by DENA or BHT exposure are testosterone-related. (auth)

3982 Regulation of ribulose 1,5-diphosphate carboxylase by substrates and other metabolites. Chu, D.K.; Bassham, J.A. (Univ. of California, Berkeley). *Plant Physiol.*; **55**: 720-726(1975).

Ribulose 1,5-diphosphate carboxylase (RuDPCase, EC 4.1.1.39) isolated from spinach leaves is metabolically regulated at 10 mM Mg^{2+} and low CO_2 concentrations by its substrates (RuDP and CO_2) and by effectors which include 6-phosphogluconate (6-PGluA), NADPH, and fructose 1,6-diphosphate (FDP), but not fructose 6-phosphate. Physiological concentrations of RuDP severely inhibit the enzyme activity when the enzyme has not been preincubated with HCO_3^- and Mg^{2+}, and this inactivity persists for 20 minutes or longer after 1 mM HCO_3^- and 10 mM Mg^{2+} are added. Maximum activity requires that the preincubation mixture also include either 0.01 mM 6-PGluA or 0.5 mM NADPH. When the enzyme, following preincubation with HCO_3^- and Mg^{2+}, is presented with RuDP plus either 6-PGluA or FDP, competitive inhibition is observed with respect to RuDP. The Ki value for 6-PGluA is 0.02 mM and the Ki value for FDP is 190 μM. NADPH or 3-phosphoglycerate (PGA) at physiological concentrations does not have any effect when presented simultaneously with RuDP. The physiological role of this regulation is discussed, particularly with respect to protection of "C-3" plants against oxidation of RuDP to phosphoglycolate. (auth)

3983 Inhibition of bacteriophage PBS2 replication in Bacillus subtilis by phleomycin. Post, L.; Price, A.R. (Univ. of Michigan, Ann Arbor). *J. Virol.*; **15**: No. 2, 363-371(Feb 1975).

Phleomycin is an effective inhibitor of the replication of Bacillus subtilis bacteriophage PBS2, whose DNA contains uracil instead of thymine. Phleomycin does not affect the induction of the known phage enzymes involved in deoxyribonucleotide metabolism. But phage DNA synthesis is severely inhibited by phleomycin, and late virion protein synthesis is eliminated. These effects appear to result from a phleomycin-induced degradation of the parental phage DNA. Similar inhibitory and degradative effects on DNA are seen in phleomycin-treated, uninfected cells. This system is unaffected by the related antibiotic, bleomycin. (auth)

3984 Effect of mutations in the qa gene cluster of Neurospora crassa on the enzyme catabolic dehydroquinase. Jacobson, J.W.; Hautala, J.A.; Case, M.E.; Giles, N.H. (Univ. of Georgia, Athens). *J. Bacteriol.*; **124**: No. 1, 491-496(Oct 1975).

Catabolic dehydroquinase, which functions in the inducible quinic acid catabolic pathway of Neurospora crassa, has been purified from wild type (74-A) and three mutants in the qa gene cluster. The mutant strains were: 105/sup c/, a temperature-sensitive constitutive mutant in the qa-1 regulatory locus; M-16, a qa-3 mutant deficient in quinate dehydrogenase activity; and 237, a leaky qa-2 mutant which posesses very low levels of catabolic dehydroquinase activity. The enzymes purified from strains 74-A, 105/sup c/, and M-16 are identical with respect to behavior during purification, specific activity, electrophoretic behavior, stability, molecular weight, subunit structure, immunological cross-reactivity, amino acid content. The mutant enzyme from strain 237 is 1,500-fold less active and appears to have a slightly different amino acid content. It is identical by a number of the other criteria listed above and is presumed to be a mutant at or near the enzyme active site. These data demonstrate that the qa-1 gene product is not involved in the posttranslational expression of enzyme activity. The biochemical identity of catabolic dehydroquinase isolated from strains 105/sup c/ and M-16 with that from wild type also demonstrates that neither the inducer, quinic acid, nor other enzymes encoded in the qa gene cluster are necessary for the expression of activity. Therefore the combined geneticand biochemical data on the qa system continue to support the hypothesis that the qa-1 regulatory protein acts as a positive initiator of qa enzyme synthesis. (auth)

3985 Effects of a glucocorticoid on the cell surface of RLC-GAI cells. Berliner, J.A.; Gerschenson, L.E. (Univ. of California, Los Angeles). *J. Cell. Physiol.*; **86**: No. 3, 523-532(Dec 1975).

The purpose of these studies was to examine the effects of a synthetic glucocorticoid, dexamethasone sodium phosphate, on the cell surface of an epithelial cell line, RLC-GAI, and to investigate the mechanism of these effects. Within hours after addition of dexamethasone sodium phosphate to the cultures, the cells begin to spread going from a more bipolar to a more epithelioid form; this change is maximal by 24 hours. In the spread cells the density of surface microvilli, as visualized in the scanning electron microscope, is considerably reduced. The changes in cell surface and shape elicited by the glucocorticoid are blocked by actinomycin D but not by hydroxyurea. Cell spreading is probably related to the configuration of cell microfilaments since these are in-

creased in numbers in the presence of the hormone and spreading is inhibited by cytochalasin B. An important role of microfilaments in the general mechanism of action of glucocorticoids is suggested. (auth)

MEDICINE

3986 (CEA-R—4680) **Bronchography using tantalum aerosols: an experimental investigation of lung clearance and retention.** Causse, A. (CEA Centre d'Etudes Nucleaires de Fontenay-aux-Roses, 92 (France). Dept. de Protection). Jul 1975. 108p. (In French). Dep. NTIS (US Sales Only) $8.50.

Thesis.

Lung clearance of tantalum used as contrast medium was studied in three animal species: rat, monkey, and cat. In rats and monkeys, 80 to 90 percent of the inhaled tantalum was removed with a half life of 10 to 30 hr, but the residual fraction was removed with a half life longer than 100 days; consequently, persistent roentgenographic pictures could be observed. These results were in accordance with those obtained by other authors studying dogs and men (accidental inhalation of radioactive tantalum). In cats, about 98 percent was removed with a half life of 15 hr and the remaining fraction with a half life of 18 days. In the three species, the physiological lung clearance mechanisms did not seem disturbed. Microscopic examination showed the peribronchiolar localization of remaining tantalum in rats and monkeys, with proliferation of granulomes and fibrotic reaction. These results indicate the need for the greatest care when using tantalum in man in order to outline peripheral airways. (auth)

3987 **Differential effects of two chemotherapeutic agents, streptozotocin and chlorozotocin, on the mammalian cell cycle.** Tobey, R.A.; Oka, M.S.; Crissman, H.A. (Los Alamos Scientific Lab., NM). *Eur. J. Cancer*; **11**: 433-441(1975).

Streptozotocin and chlorozotocin were examined for effects on survival and cell-cycle progression in exponentially growing (cycling) populations of CHO (Chinese hamster) cells and in non-cycling G1-arrested cells. On a weight basis, chlorozotocin was approximately 40 times more toxic for non-cycling cells and nearly 20 times more toxic for cycling cells in comparison to streptozotocin. While low concentrations of streptozotocin were more cytotoxic to cycling cells as compared to non-cycling cells, non-cycling cells were more sensitive than cycling cells at all concentrations of chlorozotocin examined. Streptozotocin did not affect the rate of traverse through G1 (pre-DNA synthetic phase), produced only a slight prolongation in duration of S phase (DNA-synthetic phase), and caused a delay in progression through G2 (pre-mitotic phase) of approximately 4 hr, although most cells ultimately divided. Therefore, populations treated with streptozotocin exhibited a modest increase in the fraction of cells in G2, primarily at the expense of the G1 population. Chlorozotocin, administered at an isosurvival concentration, did not affect rate of traverse of G1, approximately doubled the time required for completion of DNA synthesis, and caused cells to accumulate preferentially within the first 10 min of G2, with only a small fraction of cells capable of dividing. These population redistributions were observed whether cells were treated witheither agent in G1, G1-arrest, S, or G2. Both compounds induced mitotic non-disjunction and polyploidy. Therefore, even though chlorozotocin is a derivative of streptozotocin, the two compounds elicit very different patterns of kinetic response in susceptible cell populations. (auth)

3988 **Estrogen receptor: therapeutic guide in undifferentiated metastatic carcinoma in women.** Golumb, H.M.; Thomsen, S. (Univ. of Chicago). *Arch. Intern. Med.*; **135**: 942-945(Jul 1975).

Assay for estrogen receptor content was strongly positive in a postmenopausal patient with metastatic adenocarcinoma whose primary site of origin was undetermined. Bilateral oophorectory and adrenalectomy were performed, resulting in a progression-free period of six months. Estrogen receptor content was determined in other neoplasms, both benign and malignant. Estrogen receptor was present in a high percentage of benign and in one case of malignant endometrial neoplasms. No other neoplasm had a positive assay except for one case of papillary adenocarcinoma of the ovary. Three normal ovaries had negative assays. The presence of estrogen receptor can be used as a therapeutic guide in undifferentiated metastatic carcinoma after exclusion of abnormal pelvic findings in women. (auth)

TRACER TECHNIQUES

3989 (BNL—20564) **Use of stable helium tracer for the early detection of impaired pulmonary function.** Susskind, H.; Richards, P.; Atkins, H.L. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 20p. (CONF-751027—7). Dep. NTIS $4.50.

From 2. international conference on stable isotopes; Oak Brook, Illinois, USA (20 Oct 1975).

Methodology and instrumentation are being developed to measure distal airway closure, a very sensitive diagnostic technique for the early detection of emphysema and other obstructive lung diseases, premature closure indicating abnormalities. The procedure is rapid and involves the inhalation of only a 1-ml bolus of readily available stable ^{4}He, continuous measurement of its concentration in the exhaled air with a helium leak detector type of mass spectrometer, and the subsequent analysis of the single-breath washout curve. Helium appears to be an ideal tracer, and well-suited for testing in clinics and hospitals, as well as for epidemiological studies relating the effects of atmospheric pollutants and lung impairment and for screening of large populations for pulmonary dysfunction. (auth)

3990 (CONF-750124—, pp 1-8) **Pseudogray shade hardcopy display of nuclear medicine data using a Versatec matrix 1100A printer/plotter.** Goris, M.L.; Kriss, J.P. (Stanford Univ., CA). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Partly in an effort to reduce the operator time for each study recorded on the digital computer, and also in an attempt to produce hard copy displays with the inclusion of all relevant patient and study data, we have developed a set of algorithms allowing the introduction of patient and study data, the production of a pseudogray shade hard copy for scintigraphic images, and scaled plots for time functions using the Versatec electrostatic printer. This output device is interfaced with an HP 2100A computer (HP 5407A Digital Scintigraphic Data Analyzer), and driven under BCS. Programming is done in FORTRAN II, with a Fortran callable assembler subroutine for the binary output commands. No major developmental difficulties were met, and although the end result, for scintigraphic images, may not represent the most satisfying solution on an aesthetic basis, in general this approach avoids the uncertainties resulting when the degree of photographic manipulation is not adequately recorded. (auth)

3991 (CONF-750124—, pp 9-13) **Computer controlled, intensity modulate CRT display of data from serial radionuclide scans.** Flowers, W.M. Jr.; Smith, R.O. (Univ. of Mississippi Medical Center, Jackson). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

A computer program has been developed which has the capability of intensity modulating each location of a cathode ray tube (CRT) x-y display. For such a program to process a given number of serial radionuclide scans the intensity or brightness of any given scan must have a constant relationship to the intensity and brightness of all other scans in the series. Though black, white, and ten shades of gray have been considered to be about maximum resolution for the human eye, 32 levels were chosen because the additional levels might provide a more pleasing display. Since the number of radiation events in any given pixel may far exceed 32, it is necessary to scale each matrix so that the range becomes 0 to 31. Uniformity is accomplished by computing a single scale factor for the entire series of scans. (auth)

3992 (CONF-750124—, pp 14-19) **Display of medical images.** Pizer, S.M. (Univ. of North Carolina, Chapel Hill). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Despite the fact that controlled radionuclide studies have shown that computer processing improves the detectability of lesions, inadequate displays have produced scan images of less diagnostic usefulness than those produced by the primary device. This paper discusses an inexpensive display system that overcomes the inadequacies of most presently-used display devices. The system provides improved alphanumeric and graphics capabilities, as well as a hardware interpolation which interpolates on the fly, thus providing a gray scale image of high quality. (auth)

3993 (CONF-750124—, pp 20-28) **Direct memory access CRT display controller for display of radionuclide images.** Evans, P.L.; Kirch, D.L. (Denver VA Hospital). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

The need for high-fidelity computer output of radionuclide images is a long-standing problem in nuclear medicine computer applications. Three years ago we recognized the need for a device which would handle both static and dynamic images, permit interactive control of image display parameters, and operate with very little software overhead and CPU burden. We have built such a device and it has served reliably as the principal image output device for our dedicated PDP-12 computer system. It operates in 32 by 32 or 64 by 64 mode, has six bits of Z-axis resolution, handles areas-of-interest and cursor display functions, and permits an adjustable window to be used for selection of the Z-axis intensities to be displayed. This device is flicker-free and has been assembled using less than $1000.00 in parts (excluding the CRT), 300 man-hours of labor (including design time) and has operated with less than 1 percent down-time for $1^1/_2$ years. This device has served an invaluable role in our investigative endeavors and is indispensable in assuring maximal information extraction from routine clinical data. A PDP-11 version of this device has also been constructed for display of 128 by 128 images. (auth)

3994 (CONF-750124—, pp 29-36) **Report on the status of thyroid data bases at Vanderbilt.** Patton, J.A.; Versage, P.; Blei, L.; Price, R.; Patton, D.; Brill, A.B. (Vanderbilt Univ. Medical Center, Nashville). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

As part of the thyroid task group effort, we are developing and maintaining two data bases related to our thyroid studies. The first of these files is a specialized data set involving the results of fluorescence imaging studies (iodine content, thyroid weight, and specific iodine content). Expected ranges have been determined for each of eight possible diagnoses with this data set. The second data set is more generalized and involves the collection of data from ten thyroid studies performed on selected patients in our thyroid clinic. This data set is in the early stages of review, however we have used it to establish expected values for the 20 minute Tc-99m uptake in the three clinical thyroid states (hyperthyroid, euthyroid, and hypothyroid). Also good correlations have been obtained between the Tc-99m uptake and the 4 and 24 hour radioiodine uptake with similar diagnostic information being obtained in most cases. (auth)

3995 (CONF-750124—, pp 37-47) **Comparison of high temporal resolution left ventricular volume curves before and after mitral valve replacement.** Green, M.V.; Agress, H. Jr.; Brody, W.R.; Pearlman, A.S.; Douglas, M.A.; Ostrow, H.G.; Redwood, D.R.; Itscoitz, S.B.; Bailey, J.J.; Johnston, G.S. (National Inst. of Health, Bethesda, MD). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

A patient with severe mitral insufficiency was studied preoperatively by conventional cardiac catheterization, including left ventricular contrast angiography, and also by ECG-gated scintigraphic angiocardiography. Following mitral valve replacement the patient was again studied both by cardiac catheterization and by the scintigraphic procedure. A comparison of preoperative left ventricular volume curves derived from a frame-by-frame analysis of the contrast angiogram, and from the scintigraphic procedure, showed good agreement. A major feature of both preoperative volume curves was a large, early diastolic filling rate. The postoperative scintigraphic volume curve exhibited a marked reduction in early filling rate and a much reduced end-diastolic volume. This study suggests that the scintigraphic procedure is capable of closely following diastolic and systolic changes in left ventricular volume. (auth)

3996 (CONF-750124—, pp 48-60) **Automated selection of areas of interest in dynamic studies and camera-cinematograpy of the heart.** Bitter, F.; Adam, W.E.; Kampmann, H.; Meyer, G.; Weller, R. (Ulm Univ., Ger.). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Progress is reported in heart investigations using the first transit principle and the steady-state procedure for radionuclide scanning. Progress in the first transit principle relies on automated selection of areas of interest. A procedure has been developed which automatically performs the evaluation of the areas corresponding to the right heart, the lungs, and the left heart. A different procedure has been built up for dynamic lung studies with Xe-133 (Radiospirometry), which principally can be applied to any other organ investigation. R-wave time averaged procedures of the heart in steady state can be performed in direct or indirect manner. A direct procedure is described that leads eventually to a cinematographic presentation of the heart kinetics on the computer display. The analysis yields an exact outline of heart ventricles and auricles as prerequisite for determination of ejection fractions and clinically relevant data of the heart function. (auth)

3997 (CONF-750124—, pp 61-65) **Scan substraction to show intervention effects on myocardial perfusion.** Smith, R.O.; Markov, A.K.; Flowers, W.M. Jr.; Lehan, P.H. (Univ. of Mississippi Medical Center, Jackson). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

When control radionuclide scans are separated by several days from experimental interventions and follow-up scanning, during the interval, physiological changes may have occurred which will produce erroneous results in the later data. Currently, after the control scans are obtained, the desired intervention is produced, a second isotope bolus is given and additional scans are made. Usually, the counts in the last scan before the intervention are subtracted by a digital computer from the corresponding elements in the follow-up scans. The computer also displays the differences on an intensity modulated cathode-ray-tube. Because of the short time interval, any changes reflect the effects of the intervention alone and not other contributing factors which might have occurred during a longer intervening time. The data from mongrel dog ^{43}K heart scans suggests that combining scan subtraction with vasodilators could provide myocardial perfusion scanning information that heretofore has only been obtained by means of exercise or least squares regression analysis of serial scans made during a continuously decreasing isotope infusion. A significant advantage is that only the subtraction or regression analysis techniques provide a means of obtaining all the required data in a single scanning session even though subtraction does necessitate two bolus isotope injections. (auth)

3998 (CONF-750124—, pp 66-76) **Rapid quantitation of left to right intracardiac shunts by use of a computer-interfaced gamma camera.** Seward, J.B.; Nolan, N.G.; Tancredi, R.G. (Mayo Clinic and Mayo Foundation, Rochester, MN). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Using a gamma camera interfaced to an on-line computer, a method is described for calculating the pulmonary to systemic flow ratio (Qp:Qs) following the intravenous injection of /sup 99m/Tc pertechnetate. Compared to cardiac catheterization, this technique is more rapid, less expensive and less traumatic and is as accurate in estimating the Qp:Qs. Seventeen adult pateients with intracardiac shunts ranging from a Qp:Qs of 1.1 to 4.6 were correctly diagnosed and their shunts accurately quantitated by this method. Eight control subjects and six patients with clinically suspected intracardiac shunts were correctly diagnosed as having no shunt. (auth)

3999 (CONF-750124—, pp 115-126) **Measurement and comparison of left ventricular ejection fraction utilizing first transit and gated scintiangiography.** Fletcher, J.W.; Herbig, F.K.; Daly, J.L.; Walter, K.E. (St. Louis Univ. School of Medicine). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Paired serial radionuclide scans were used for determinations of left ventricular ejection fraction (LVEF) in open chest dogs with constant cardiac output and varying ventricular rates following the left atrial injection of 99m-Tc human serum albumin. Values of LVEF obtained by first transit (high frequency) data analysis and ECG-gated scintiphotography were obtained over a wide range of ventricular rate and stroke volume. The results of this study show no significant difference in LVEF as determined by both of these methods of data acquisition and analysis and demonstrate the feasibility of rapid serial determination of LVEF by radioisotope techniques. (auth)

4000 (CONF-750124—, pp 127-137) **Application of a computerized image-intensifier radionuclide imaging system to the study of regional left ventricular dysfunction.** Kirch, D.L.; Steele, P.P.; LeFree, M.T.; Evans, P.L.; Stern, D.M. (Denver VA Hospital). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

The spatial and temporal operating characteristics of an image intensifier camera (IIC) have been measured and compared with those of an Anger camera (AC) for performing high count-rate dynamic studies of the heart. This study shows the AC has slightly better spatial resolution at count-rate below 40 Kcps but the IIC has better count-rate linearity (within 1 percent up to 600 Kcps) and improved detection efficiency. These properties make the IIC the instrument of choice in performing radionuclide angiocardiographic (RA) studies of the left heart. We have developed two techniques for demonstrating regional ventricular dysfunction using the computerized data from the IIC. These two techniques are termed the silhouette difference image (SDI) and the regional ventricular function image (RVF). Because these functional images combine two single 50 millisecond frames of data, the higher sensitivity and count-rate linearity of the IIC system is essential for performing these studies. (auth)

4001 (CONF-750124—, pp 138-154) **Update of the computer analysis of cephaloangioscintigraphy data.** McLaughlin, W.T.; Price, D.D.; Butler, T.; Scheibe, P.O. (Santa Clara Valley Medical Center, San Jose, CA). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

In an effort to reduce the variability and increase the accuracy of the qualitative data obtained from the gamma scintillation camera, a minicomputer was used to process information obtained during the dynamic perfusion of the 99m technetium injected intravenously into patients referred for routine brain scintigraphy (brain scan). The paired bylateral regions of interest are selected over the carotid, middle and anterior cerebral arteries. Time function curves are generated for each region of interest and analyzed for the injection to arrival time, arterial phase and venous phase. Ratios of the smallest over the largest of the total count in the paired time segments are calculated for each of the regions of interest. A total of 263 cases have been studied. The 2 standard deviation ranges for the right to left ratios have been calculated for the group of 81 normal patients. The 2 standard deviation ranges for the circulation times in the 3 regions of interest have been calculated in the injection to arrival, arterial and venous phases in a group of 59 patients. The 2 standard deviation range for the right to left variation in the time of arrival, peak time and venous plateau has also been calculated. This data is presented, 1 normal and 1 abnormal case are used to illustrate the use of the technique clinically. The preliminary work validates the work of other investigators and suggests that this is a clinically useful procedure and a positive aid to diagnosis. Based on this initial work, further refinement of the technique is currently being undertaken in an effort to automate the procedure and make it more feasible to clinical nuclear medicine. (auth)

4002 (CONF-750124—, pp 155-160) **Xenon ventilation-perfusion lung scintigraphy immediately following technetium microsphere scanning: a computer-assisted background subtraction technique.** Nolan, N.G. (Mayo Clinic and Mayo Foundation, Rochester, MN). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

The conventional /sup 99m/Tc-albumin capillary blockade type of radionuclide lung scan suffers from a lack of sensitivity in identifying small perfusion defects and from an inability to distinguish between the various causes of perfusion defect. This paper presents a simple computer-assisted technique which allows a ^{133}Xe ventilation-perfusion (V:Q) study to be performed immediately after the /sup 99m/Tc-albumin microsphere scans with the gamma camera optimally positioned over any defect that is seen. Crossover from the /sup 99m/Tc into the ^{133}Xe window is subtracted from the xenon study by the computer. This procedure allows advantage to be taken of a unique character of the acute pulmonary embolus, namely an elevation of the V:Q ratio in the affected area of lung. In this way, the specificity of the lung scan can be increased for pulmonary embolism. (auth)

4003 (CONF-750124—, pp 161-171) **Simple functional image of lung ventilation: the mean transit time.** Alpert, N.M.; Correia, J.A.; McKusick, K.A.; Shea, W.; Brownell, G.L.; Potsaid, M.S. (Massachusetts General Hospital, Boston). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

The mean transit time (anti t) computed from Xe-133 washout measurements provides an estimate of ventilation from which a functional image of the lung can be generated. The computation can be done faster than that of any previously discussed method and it can be easily implemented on most available nuclear medicine computer systems. Functional images of ventilation computed from this method were used in the evaluation of over 60 adult patients referred for standard perfusion lung scans because of the possibility of pulmonary embolism. Since the functional image utilizes all of the data collected during washout, its statistical quality is superior to that of individual washout images obtained with sequential imaging techniques. It is our impression that this rapid, simple-to-derive functional image of ventilation provides information not apparent on standard sequential images taken during washout. (auth)

4004 (CONF-750124—, pp 172-179) **Radionuclidic renal imaging and computers.** Bradley-Moore, P.R. (The Mount Sinai Hospital, New York). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Progress is reported in the application of computers to the problem of radionuclidic imaging of the kidneys. Advances can particularly be expected with the advent of high useful flux agents allowing statistically more reliable curves or images from subdivisions of the whole kidney, with the imaging process itself progressively being improved by increase in resolution and speed of Anger cameras. Results are reviewed from studies of regional kidney function using /sup 99m/Tc and ^{131}I-labeled compounds as tracers. (CH)

4005 (CONF-750124—, pp 180-194) **Application of computer-generated functional (parametric) maps in radionuclide renography.** Agress, H. Jr.; Levenson, S.M.; Gelfand, M.J.; Green, M.V.; Bailey, J.J.; Johnston, G.S. (National Inst. of Health, Bethesda, MD). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

A functional (parametric) map is a single visual display of regional dynamic phenomena which facilitates interpretation of the nature of focal abnormalities in renal function. Methods for producing several kinds of functional maps based on computer calculations of radionuclide scan data are briefly described. Three abnormal cases are presented to illustrate the use of functional maps to separate focal lesions and to specify the dynamic nature of the abnormalities in a way which is difficult to achieve with conventional sequential renal scans and renograms alone. (auth)

4006 (CONF-750124—, pp 195-208) **Dedicated computer analysis of the radioiodine renogram.** Bronstein, R.M.; George, D.L.; Parker, J.A.; Rose, J.G. (Medical Coll. of Pennsylvania, Philadelphia). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

One of the problems with renogram quantification is the estimate of the contribution to the kidney counts by extra-renal activity. Britton and Brown have proposed a blood background subtraction method using a three probe system. Esser, et al. have applied this method to a scintillation camera-dedicated computer system. The work reported here is a further extension of this method. Hardware consists of the Gamma-11 nuclear medicine computer manufactured by Digital Equipment Corporation. Analysis is through a combination of the Gamma-11 software and a user written program in FOCAL. The entire study consists of four imaging sequences: a ^{197}Hg static, a ^{131}IHSA image for background subtraction, the ^{131}I-Hippuran renogram, and a /sup 99m/Tc-DTPA flow study. Time required for analysis is 15 to 20 minutes, including a three minute computer program run. (auth)

4007 (CONF-750124—, pp 209-217) **Computerized technique for evaluating renal transplant function.** Shames, D.M.; Farmer, R.E.L.; Wright, R.R.; Rollo, F.D.; Swann, S.J.; Salvatierra, O. Jr. (Univ. of California, San Francisco). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

This investigation was undertaken to improve the assessment of renal transplant function in the early post-operative period when the usual measures of renal function afford little useful information. A simplified mathematical model of I-131 hippurate transport allows separation of renal uptake and excretion. Uptake (U) is defined as the fraction of I-131 hippurate in the plasma picked up by the kidney per minute, and excretion (E), the fraction of I-131 hippurate in the kidney excreted into the bladder per minute. Scintillation camera data from the region of the renal allograft are framed at 4/min by a computer system for up to 30 minutes post injection. After regions of interest are flagged over the kidney, bladder and background regions, the activity-time curves are analyzed, and values for U and E are output in a report updated through punched paper tape for any values from previous studies. The entire analysis of a patient study requires about 5 minutes of technologist time. Over 150 studies on 24 patients have been analyzed using the above technique. In the immediate post-operative state when anuria or severe oliguria is often present, sequential estimation of U was found to be a sensitive measure of renal transplant viability. In the period beyond one week reductions in U and E appeared to be sensitive measures of rejection, while increases in U and E heralded amelioration of the rejection episode. Changes in U and E appeared to be more sensitive measures of changes in renal function than routine qualitative scintiphotographic analysis. This technique has proven useful in following the renal function status of the kidney transplant recipient through acute tubular necrosis and rejection episodes and has been a significant adjunct to routine scintigraphy. (auth)

4008 (CONF-750124—, pp 218-225) **Interactive computer system for analysis of dynamic renal studies.** Cahill, P.T.; Ornstein, E. (Polytechnic Inst. of New York). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

An interactive computer system is described for a small minicomputer to be used in the evaluation of radionuclide scintiscanning studies of renal transplants and other dynamic kidney function studies. The package consists of programs for data acquisition, analysis, and report generation. As an added feature, the program dissociates the kidney view into total kidney, cortical, and medullar components. (auth)

4009 (CONF-750124—, pp 226-228) **Laboratory management functions of computers in nuclear medicine.** Cradduck, T.D. (Univ. of Toronto). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

The remarkable growth of the use of digital computers in nuclear medicine has resulted in the application of these devices in many routine clinical areas. The basic needs within these clinics of data collection, storage, analysis, and display have been fulfilled to a great extent. Additional applications, including radiotherapy, in vitro studies, and computer-aided instruction are being explored. Laboratory data management is the one new area common to all clinics. The importance and the required capabilities of laboratory data management systems are discussed. (auth)

4010 (CONF-750124—, pp 229-232) **Level of confidence in nuclear medicine.** Wenzel, W.W.; Kenney, G.N.; Avery, P.A. (Presbyterian Medical Center, Denver). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

In a private hospital nuclear imaging laboratory, the digital computer can add additional dimensions to the level of confidence of studies by providing additional information of dependable quality. Several factors, however, must be taken into account when one is considering the purchase of a computer for use in an active clinic. A time-shared computer system which is always available to physicians for analysis of studies, while simultaneously permitting data acquisition, processing, and program development, is discussed. (auth)

4011 (CONF-750124—, pp 233-240) **Implementation of a nuclear medicine network.** Herbig, F.K.; Fletcher, J.W.; Daly, J.L. (St. Louis Univ. School of Medicine). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

A nuclear medicine information network is described which links three Veterans Administration Hospitals in rural Missouri and Illinois to the nuclear medicine service of the John Cochran Hospital in St. Louis, Missouri. By utilizing computer acquisition of pre-defined studies and synchronous telephone transmission of the acquired images to the central site, analysis of both static and dynamic studies is available to the remote hospitals without a nuclear medicine specialist in residence. (auth)

4012 (CONF-750124—, pp 241-250) **Analytical techniques for image superposition.** Price, R.R.; Lindstrom, D.P.; Hillis, S.; Friesinger, G.C.; Brill, A.B. (Vanderbilt Univ. Medical Center, Nashville). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Analytical techniques for superimposing images of the same organ made at different times are described. The images may be either from the same or different instruments with different magnifications, rotations and distortions. Examples of superimposed images presented include: scanner images superimposed with scintillation camera images; and digital contrast arteriograms superimposed with camera images. Other applications of the techniques are suggested. (auth)

4013 (CONF-750124—, pp 251-261) **Computer technique for evaluating collimator performance.** Rollo, F.D. (Univ. of California, San Francisco). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

A computer program has been developed to theoretically evaluate the overall performance of collimators used with radioisotope scanners and γ cameras. The first step of the program involves the determination of the line spread function (LSF) and geometrical efficiency from the fundamental parameters of the collimator being evaluated. The working equations can be applied to any plane of interest. The resulting LSF is applied to subroutine computer programs which compute corresponding modulation transfer function and contrast efficiency functions. The latter function is then combined with appropriate geometrical efficiency data to determine the performance index function. The overall computer program allows one to predict from the physical parameters of the collimator alone how well the collimator will reproduce various sized spherical voids of activity in the image plane. The collimator performance program can be used to compare the performance of various collimator types, to study the effects of source depth on collimator performance, and to assist in the design of collimators. The theory of the collimator performance equation is discussed, a comparison between the experimental and theoretical LSF values is made, and examples of the application of the technique are presented. (auth)

4014 (CONF-750124—, pp 263-284) **In vitro test programming at Vanderbilt.** Erickson, J.J.; Versage, P.M.; Brill, A.B. (Vanderbilt Hospital, Nashville). 1975.

From 5. symposium on sharing of computer programs and technology in nuclear medicine; Salt Lake City, Utah, USA (15 Jan 1975).

In Proceedings of fifth symposium on sharing of computer programs and technology in nuclear medicine.

Demands being placed upon the medical community from several sources have initiated renewed interest in and immediate requirements for standardized nomenclature and terminology for use in medical reporting systems. These problems and their solutions provided the central focus of the Fourth Annual Conference of the Society of Nuclear Medicine. General sessions and workshops highlighted the demands being placed on medicine as well as some steps that have been taken to meet these demands. Representatives of twelve medical societies and academies met as an Ad Hoc Committee during the conference to review the needs and to consider steps necessary to develop a standardized com-

puter-supported reporting system that would: bridge the growing gap between existing formal knowledge and bedside decisions; permit an organized presentation of clinical signal data; provide scientific definitions and current research findings to enable a clinician to retrieve scientific facts pertinent to his case; and provide the mechanism necessary for uniform peer review with sufficient feedback to upgrade medical case. This paper contains a report on the Fourth Annual Conference of Computer Medicine including some facts about this organization, some opinions, a brief review of presentations made concerning Standardized Languages, and a report on the Ad Hoc Committee meetings. (auth)

4015 Osteosclerosis in primary hyperparathyroidism. Genant, H.K.; Baron, J.M.; Straus, F.H. II; Paloyan, E.; Jowsey, J. (Univ. of Chicago). *Am. J. Med.;* **59**: 104-113(Jul 1975).

Osteosclerosis in adults with primary hyperparathyroidism is rare; the usual skeletal manifestation, when present, is diffuse osteopenia. We describe a patient with generalized osteosclerosis in association with primary hyperparathyroidism. The findings are documented by conventional and fine-detail radiography, absorptiometric bone mineral analysis, quantitative microradiography and histologic examination of bone. The unique features are contrasted with the manifestations recorded in a recently studied group of 87 hyperparathyroid patients. The data presented here support a causal relationship in this patient between parathyroid hormone excess and the development of densely sclerotic bones. (auth)

4016 Quinoline analog labeled with ^{123}I in melanoma detection. Packer, S.; Redvanly, C.; Lambrecht, R.M.; Wolf, A.P.; Atkins, H.L. (Brookhaven National Lab., Upton, NY). *Arch. Ophthalmol. (Chicago);* **94**: 504-508(Jul 1975).

Using the Greene melanoma in the hamster (Syrian Golden), the radiopharmaceutical, ^{123}I-4(3-dimethylaminopropylamino)- 7-Iodoquinoline, was tested for its ability to localize melanoma. This quinoline analog has been described for use in the detection of melanoma, but this is the first report, to our knowledge, of its being used with an ^{123}I label. Hamsters with either skin or eye melanomas were studied. Both melanomas could be seen with a gamma camera at three hours after injection. In vitro analysis confirmed the tumor specificity. Thus, it appears that this preclinical trial of a new radiopharmaceutical justifies clinical testing to determine its value in the localization of melanomas of the eyes and skin of humans. (auth)

MICROBIOLOGY

4017 Influence of substrate wettability on the attachment of marine bacteria to various surfaces. Dexter, S.C.; Sullivan, J.D. Jr.; Williams, J. III; Watson, S.W. (Woods Hole Oceanographic Institution, MA). *Appl. Microbiol.;* **30**: No. 2, 298-308(Aug 1975).

The effect of the initial subtrate surface condition, as indicated by the critical surface tension for wetting, on the rate of attachment of marine bacteria to a variety of solid surfaces has been measured. The techniques used to determine the number of bacteria attached per unit surface area were a lipopolysaccharide test utilizing Limulus lysate and direct examination of the surface by scanning electron microscopy. The results obtained by the two techniques are compared and their significance to the control of microbiological slime film formation (microfouling) is discussed. (auth)

4018 Genetic mapping of a mutation that causes ribonuclease III deficiency in Escherichia coli. Studier, F.W. (Brookhaven National Lab., Upton, NY). *J. Bacteriol.;* **124**: No. 1, 307-316(Oct 1975).

The mutation that causes ribonuclease III (RNase III) deficiency in strain AB301-105 of Kindler et al. (1973) has been mapped by use of F′ merodiploids, Hfr matings, and P1 transduction. This mutation, rnc-105, lies close to nadB, near 49 min on the genetic map of Escherichia coli. The rnc-105 mutation has been transferred from its original genetic background by transduction and conjugation, and these new strains have the same defects in ribonucleic acid processing reported previously for AB301-105. Strains that carry rnc-105 grow more slowly than parental rnc^+ strains, but the difference in growth rate seems to depend on the genetic background of each strain. Bacteriophage T7 grows about equally well in RNase III^+ and III^- female strains of E. coli, even though the specific cuts that RNase III makes in T7 ribonucleic acid are not made in the RNase III^- strains. A low-phosphate defined medium in which most E. coli strains seem to grow well was developed. This medium is equally useful for labeling ribonucleic acids with $^{32}PO_4$ and as a selective medium for genetic manipulations. It was used to determine the growth requirements of strain AB301-105, which are biotin and succinate in addition to the methionine and histidine requirements of the parental strain. The biotin mutation lies near the position expected from known mutations of E. çoli, but the succinate mutation apparently does not. The possiblity that the succinate requirement could be due to the RNase III deficiency is discussed. A uraP mutation was isolated for use in transferring rnc-105 between strains by conjugation. It lies near 47 min, somewhat removed from the commonly accepted position for uraP. (auth)

MORPHOLOGY

4019 Lateral hermaphroditism in a C3H mouse. Holland, J.M. (Oak Ridge National Lab., TN). *Lab. Anim. Sci.;* **25**: No. 4, 474-476(1975).

A spontaneous case of true lateral hermaphroditism was observed in one of approximately 1000 necropsies of 12-wk-old female C3Hf-Wg mice (a substrain of C3H/He). Both the right ovary and abdominal left testis were functional as evidenced by the presence of oocytes in graffian follicles and spermatocytes maturing on sertoli cells. Both gonads communicated, the ovary via an oviduct and normal right uterine horn and the testis via an epididymus and vas deferens, with a vagina which ended in a blind pouch and was filled with squamous debris. (auth)

PATHOLOGY

4020 (SAND—75-6008) Effect of a magnetic field on the development of experimental tumors in pelargonium zonale. Magrou, J.; Manigault, P. Translated from *C. R. Hebd. Seances Acad. Sci.;* **203**: 8-11(1936). 5p. Dep. NTIS $4.50.

Results are reported on studies on the effect of a magnetic field on tumors produced by the inoculation of Phytomonas tumefaciens (agent of crowngall or plant cancer) into the stem of Pelargonium zonale. (CH)

4021 Species differences in the effect of benzo(a)pyrene-ferric oxide on the respiratory tract of rats and hamsters. Schreiber, H.; Martin, D.H.; Pazmino, N. (Oak Ridge National Lab., TN). *Cancer Res.;* **35**: 1654-1661(Jul 1975).

When given intratracheal injections of a suspension of benzo(a)pyrene-ferric oxide, rats and hamsters showed striking species differences in the response of their respiratory tracts to the carcinogen. Hamsters produced squamous metaplasia of the trachea and large bronchi; in contrast, squamous cell nodules of bronchioloalveolar origin developed in rats within a few weeks after carcinogen application. The different sites of the early proliferative and metaplastic responses correlated in their location with the sites of later tumor development. There were no obvious differences between the two species in retention of benzo(a)pyrene in the lungs or tracheas. A species difference was observed, however, in the localization of the benzo(a)pyrene in the tracheal tissues using ultraviolet fluorescence microscopy. Carcinogen was found to be present in the epithelium of hamsters but not in the epithelium of rats, suggesting a species difference in penetration of carcinogen from the lumen into the tracheal tissues. (auth)

4022 Cartilage repair over porous metal implants. Karagianes, M.T. (Battelle Pacific Northwest Labs., Richland, WA); Wheeler, K.R.; Nilles, J.L. *Arch. Pathol.;* **99**: 398-400(Jul 1975).

Porous metal test plugs were implanted in the weight-bearing area of the medial condyles in femora of African pygmy goats. These specimens were examined for new cartilage overgrowth at $1^1/_2$, four, and 18-months postimplantation. One and one half-month implants showed partial tissue repair over the exposed ends of the plugs and partial-to-complete tissue coverage had occurred in the four- and 18-month specimens. The new tissue was similar to hyaline cartilage, especially in the early implants, though matrical areas devoid of cells and poor chondrocyte orientation were found in long-term specimens. Animal activity was not noticeably impaired. (auth)

TRACER TECHNIQUES

4023 (BNWL-SA—5576) Investigation of the role of oncornavirus in radiation-induced osteosarcomas. Frazier, M.E.; Park, J.F.; Jee, W.S.S.; Taylor, G. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(11-1)-119. 15p. (CONF-751043—6). Dep. NTIS $4.50.

From Workshop on the biological effects and toxicity of Pu 239 and Ra 226; Sun Valley, Idaho, USA (6 Oct 1975).

Viruses of the RNA tumor group are etiologic agents of spontaneously occurring neoplastic disease in a number of animal species. These oncornaviruses possess certain biochemical properties which permit them to be easily detected in infected cells, in-

cluding RNA-instructed DNA polymerase (RIDP) and a closely associated 70S RNA genome in a cytoplasmic particulate fraction having a density of 1.15-1.20 g/ml. Tissues from three dogs with radiation-induced lung tumors and four dogs without tumors did not contain RIDP. However, RIDP was detected in materials prepared from five beagles with radiation-induced osteosarcomas. The presence of RIDP in these radiation-induced osteosarcomas can be considered indicative of retravirus or oncornavirus infection. (auth)

PHYSIOLOGICAL SYSTEMS

4024 Comparative photosynthetic production of Mojave Desert shrubs. Bamberg, S.A.; Kleinkopf, G.E.; Wallace, A.; Vollmer, A. (Univ. of California, Los Angeles). *Ecology;* **56**: No. No. 3, 732-736(Spr 1975).

Transpirational and net photosynthetic rates of several species of desert shrubs were measured as a function of season and environmental variables at the Nevada Test Site in the northern Mojave Desert. Drought(deciduous species, Ambrosia dumosa (Grey) Payne, Lycium andersonii Grey, and Lycium pallidum Miers, had higher maximum rates and greater water loss than the evergreen, Larrea tridentata Munz, and summer green, Krameria parvifolia Benth., species. Moisture status was the most critical factor determining gas exchange rates and affected temperature optima and acclimation as the season progressed. Because of a dry spring season, the drought-deciduous species became dormant in late May—early June; the other two species exhibited by mid-June a small positive CO_2 uptake during the morning period. Desert plant species, with few exceptions, are extremely labile and exhibit large variability and different adaptive strategies. (auth)

4025 Direct contact with enriched environment is required to alter cerebral weights in rats. Ferchmin, P.A.; Bennett, E.L.; Rosenzweig, M.R. (Univ. of California, Berkeley). *J. Comp. Physiol.;* **88**: No. 1, 360-367(1975).

To test the relative effectiveness of direct vs. indirect interaction with an enriched environment, some rats were housed in groups of 12 in large enriched condition (EC) cages while littermate observer (OC) rats were placed singly in small wire-mesh cages within EC. A third group was housed singly in an impoverished condition (IC) where stimulation was minimal. After 30 days, the animals were killed and the brains dissected. In both experiments the usual pattern of EC—IC differences in brain weights appeared, whereas OC showed no significant differences from IC. On measures of exploratory behavior taken during the last 2 days of the second experiment, IC fell significantly below EC, and OC was somewhat below IC. Thus EC differed from both IC and OC in brain and in behavior. Active contact with an enriched environment appears necessary for development of EC effects. (auth)

4026 Effects of protein synthesis inhibition on memory for active avoidance training. Flood, J.F.; Bennett, E.L.; Orme, A.E.; Rosenzweig, M.R. (Univ. of California, Berkeley). *Physiol. Behav.;* **14**: 177-184(1975).

Inhibition of brain protein synthesis by anisomycin and acetoxycycloheximide was studied in mice for its biochemical and behavioral effects. By employing both drugs in low doses in a series of injections, we were able to maintain inhibition of protein synthesis of 80 percent or greater for up to 14 hr without causing detectable permanent physiological impairment. The drugs were employed as amnestic agents in mice trained to avoid footshock in a T-maze. As the duration of inhibition increased, the percentage of mice classed as amnesic increased. This amnesia could be reduced by increasing the rate of acquisition, or the number of training trials. Anisomycin was shown to cause a significant degree of amnesia for the escape component as well as the avoidance component of the learning. A single injection of anisomycin given 15 min prior to training did not cause significant changes in the acquisition or retention of avoidance conditioning, when comparison was made with saline-injected controls. Only additional injections given after training to prolong inhibition caused amnesia. Thus, those injections critical in obtaining amnesia were given at a time at which interference with acquisition could not have occurred, so the results bear clearly on memory processes. (auth)

4027 Sodium relations in desert plants. IV. Some physiological responses of Atriplex confertifolia to different levels of sodium chloride. Kleinkopf, G.E.; Wallace, A.; Cha, J.W. (Univ. of California, Los Angeles). *Soil Sci.;* **120**: No. 1, 45-48(1975).

Atriplex confertifolia (Torr, Frem.) Wats. seedlings were grown in soil irrigated with different salt levels. Maximum yields were obtained with a 50 me/liter NaCl treatment. Higher salt levels produced large, succulent leaves showing symptoms of nitrogen deficiency. Physiological effects of salt were noted as decreased chlorophyll, soluble protein, and nitrate and loss of nitrate reductase activity. Salt also reduced the uptake of Mg, K, and P. Net carbon assimilation rates were reduced presumably from salt-induced increases in respiration. Leaf water potential was decreased greatly by the salt levels, but transpiration levels at leaf temperature of 20°C did not correspond in that they were quite insensitive to salt levels. At 30°C, transpiration rates decreased with increasing salt indicating an improved water use efficiency. (auth)

4028 Unusual fertilization of a grasshopper mouse, Onychomys leucogaster. Contract AT(45-1)-1830. *Am. Midl. Nat.;* **93**: No. 1, 255-256(Jan 1975).

A female northern grasshopper mouse, Onychomys leucogaster fuscogriseus, delivered a litter 19 days after weaning an earlier litter, and 152 days since separation from all males. There was no opportunity for the female to accidentally encounter a male in the interval. A combination of circumstances, including breeding just prior to parturition, survival of sperm during parturition and an extended gestation period during lactation, could explain the observed reproductive anomaly. (auth)

4029 Thermoregulatory, metabolic, and cardiovascular response of rats to microwaves. Phillips, R.D.; Hunt, E.L.; Castro, R.D.; King, N.W. (Battelle Pacific Northwest Labs., Richland, WA). *J. Appl. Physiol.;* **38**: No. 4, 630-635(Apr 1975).

This study was undertaken to determine the effects of 2,450-MHz microwave irradiation on thermoregulation, metabolism, and cardiovascular function of rats. Young adult male animals (430 g) were exposed for 30 min to 2,450-MHz microwaves in a cavity at absorbed dose rates of 0, 4.5, 6.5, or 11.1 mW/g. For animals of the size used in this study, these dose rates represent absorption of energy at the rate of 27.7, 40.1, and 68.2 cal/min, respectively. For a period of 5 h following exposure, measurements were made of colonic temperature, skin temperature, oxygen consumption, carbon dioxide production, respiratory quotient, and heart rate. Rats that received 27.7 cal/min for 30 min exhibited an initial transient increase in colonic and skin temperatures but no alterations in other functions. The group irradiated at 40.1 cal/min had greater elevations in colonic and skin temperatures immediately after exposure, followed by overcompensation and lower than normal colonic temperatures for about 3 h. The metabolic rate was depressed in this group for 3 h. Bradycardia developed within 20 min after exposure and persisted for about 3 h. The group of rats that received 68.2 cal/min for 30 min had responses similar to those of the 40.1 cal/min group, but the changes were more severe and lasted longer. In addition, a number of transient abnormalities were noted in the ECG tracings of rats that had received the highest dose, including irregularrhythms and incomplete heart block. The physiological changes observed in this study can be attributed to the heating induced by irradiation. (auth)

4030 Identification of phthalic acid esters in the tissues of cyprinodont fish and their activity as heartrate depressors. Pfuderer, P.; Janzen, S.; Rainey, W.T. Jr. (Oak Ridge National Lab., TN). *Environ. Res.;* **9**: No. 3, 215-223(Jun 1975).

Two substances isolated from carp liver have been identified as dioctyl phthalate and butylbenzyl phthalate. When partially purified from fish liver by two-step column chromatography, these esters exhibited heartrate depressor activity. A pure sample of dioctyl phthalate was not active in the assay, however, while a sample of butylbenzyl phthalate containing 1.5 percent dibutyl phthalate was slightly active, probably due to the dibutyl phthalate it contained. A third phthalate ester, dibutyl phthalate, has also been found in carp liver, in lower concentrations than the other esters, and is a heartrate depressor. Pure samples of dibutyl phthalate remained active at levels of 5 ppm and higher. We are forced to conclude either that traces of a compound which complexes or enhances the activity of dioctyl and butylbenzyl phthalate is responsible for their activity, or that traces of a more active compound are present with them. Dioctyl phthalate was also shown to form complexes in ethanol with fish lipids, presumably with fish di- and triglycerides. (auth)

4031 Alloantigen expression of a rat Moloney sarcoma. Jones, J.M.; Feldman, J.D. (Scripps Clinic and Research Foundation, La Jolla, CA). *J. Natl. Cancer Inst.;* **55**: No. 4, 995-999(Oct 1975).

Cells of a brown Norway (BN) rat Moloney sarcoma (MST) failed to express certain BN alloantigen specificities and bound only about 30-50 percent the amount of labeled alloantibody bound by normal BN spleen cells. MST cells lacked antigen specificities shared by BN and WF rats, but expressed some of the antigen shared by BN and AUG rats. Further loss of alloantigens that occurred with prolonged in vitro culture was associated with reduced virulence of MST cells for syngeneic hosts and with increased expression of tumor-associated antigens. The LEW rats, which are resistant to MST cells, might have rejected the tumor on the basis of factors other than Ag-B antigens. (auth)

PUBLIC HEALTH

4032 (ORNL-tr—2975) **Tolerance levels for toxic substances in drinking water.** Stofen, D. Translated by R.G. Mansfield from *Staedtehygiene;* **24**: No. 5, 109-114(1973). 13p. Dep. NTIS $4.00.

This paper presents a translation of the valid list of the (294) Soviet Standards for harmful substances in drinking water and supplements it by a survey of the present situation of toxicology in the Federal Republic of Germany and the USSR. Competent West German toxicologists have declared the West German standards for atmospheric pollutants to lack a sound scientific foundation on a considerable scale. The information of Henschler on his ideas for further development of toxicology, the present situation of which is not satisfactory, covers an extension of basic research and the development of MACs on the basis of carcinogenic, mutagenic, and teratogenic effects, for which no-effect-doses do not exist. The Soviet standards are based on thresholds of functional, especially neurologic-behavioral, disturbances. Soviet toxicology seemingly continues to be ignored in West Germany, though it promises at least some protection against functional-degenerative diseases. The shortcomings of the Soviet standards for drinking water are discussed, especially the insufficient attention which it pays to the special problems of children. The development of standards for drinking water without acceptance of the Soviet values would probably take several decades. (auth)

AGRICULTURE AND FOOD TECHNOLOGY

4033 **Methods of assessing the primary production of regions.** Sharpe, D.M. pp 147-166 of In Primary productivity of the biosphere. Lieth, H. (ed.). New York; Springer-Verlag, Inc. (1975).

Most published work on primary production has been done at the local level. Estimates of production for regions have been based upon extrapolations from small samples of stand productivities. Recently, regional production rates have been studied in a more integrated manner, for example, in the Biome and Regional Analysis Program of the Eastern Deciduous Forest Biome Program, which is one of the contributions of the United States to the International Biological Program (IBP). The objective of this chapter is to review the methods used in estimating primary production rates for specific regions, and to suggest directions for improvement. (auth)

BIOMEDICAL SCIENCES, APPLIED STUDIES

RADIATION EFFECTS ON BIOCHEMICALS

IN VITRO

4034 **ESR and ENDOR studies of irradiated nucleic acid constituents.** Box, H.C.; Freund, H.G. (Roswell Park Memorial Inst., Buffalo). *Ann. N.Y. Acad. Sci.;* **222**: 446-451(31 Dec 1973).

As repositories of genetic information the nucleic acids are the seat of mutational changes. Consequently, when the power of electron spin resonance (esr) spectroscopy for analyzing radiation effects became apparent, many investigators were quick to apply esr to the study of radiation damage in nucleic acids and their constituents. The main difficulty in most such studies is identification of the radiation-produced radicals from their esr spectra. As technology improves, the prospect of making unambiguous identifications improves. Perhaps the most important new asset in radiation damage studies has been the introduction of electron-nuclear double resonance (endor) spectroscopy. In this paper we explore the potential significance of endor and other improved techniques for the study of radiation damage in nucleic acid constituents. (auth)

4035 **Properties of the ultraviolet-light-mediated binding of bovine serum albumin to DNA.** Braun, A.; Merrick, B. (Brandeis Univ., Waltham, MA). *Photochem. Photobiol.;* **21**: 243-247(1975).

The binding of DNA to protein mediated by uv (254 nm) radiation has been investigated using binding of the complex to Millipore membrane filters as an assay technique. The reaction proceeds through an activated protein intermediate which then reacts with the DNA. The activated protein has a half-life of about 75 min at 0°C and about 18 min at 37°C. Short wavelengths are more efficient in forming the complex than wavelengths in the 250-280 nm range. N-ethyl maleimide treatment of protein before irradiation markedly inhibits the reaction. (auth)

4036 (ERDA-tr—51, pp 6-12) **Appearance of defects of the primary structure of x-irradiated DNA in vitro in kinetic experiments.** Fonarev, A.B.; Shugalii,A.V.; Todorov, I.N.; Paskevich, I.F. (Academy of Sciences, Ukrainian SSR, Kiev). 1975. Translated from Radiobiologiya; 15: No. 2, 175-180(1975).

In Radiobiology.

In the x irradiation of 0.025 percent solutions of DNA, isolated from the calf thymus, the nature of the distribution of defects of the primary and secondary structures, as well as the influence of these disorders on the kinetics of reassociation, was investigated. The nature of the distribution of defective sites along the chain of the macromolecule is discussed. It was shown that the kinetics of the reassociation of irradiated DNA preparations is complex, differing from the kinetics of the native preparation. It was established that at a dose of 3 kR the distribution of defects along unique and repetitive sequences is close to equiprobable. (tr-auth)

4037 (ERDA-tr—51, pp 22-25) **Influence of ultraviolet and x rays on the chromophore groups of proteins in solutions.** Buturlakin, M.S.; Shmelev, V.P. (Voronezh State Univ., USSR). 1975. Translated from Radiobiologiya; 15: No. 2, 189-192(1975).

In Radiobiology.

The changes in the differential absorption spectra of solutions of blood serum induced by uv and x rays and the perturbation absorption spectra of solutions of human gamma-globulin were studied. The ratio of the changes in the positions of the maxima of the perturbation absorption spectra of the tyrosine and tryptophan amino acid residues under the influence of uv rays is evidence of a relatively great vulnerability of the tyrosine amino acid residues in comparison with the tryptophan residues under the influence of x rays. It was suggested that there is an interrelationship of the absorption at the wavelength 235 nm with conformational rearrangements, caused by the influence of radiation on the protein macromolecules. (tr-auth)

IN PLANTS

4038 (ERDA-tr—51, pp 106-109) **Study of the modifying action of caffeine on certain biosynthetic processes in gamma-irradiated pea roots.** Golikova, O.P. (Academy of Sciences Ukrainian SSR, Kiev). 1975. Translated from Radiobiologiya; 15: No. 2, 269-272(1975).

In Radiobiology.

In connection with the problem of postradiation recovery of plants from ionizing radiations and the participation of repair processes in it, the modifying action of caffeine on the synthesis of DNA, RNA, and protein, as well as on growth processes in γ-irradiated pea seedlings was studied. On the basis of the experimental material cited, it can be assumed that caffeine in nonirradiated tissues has an effect on transcription and protein synthesis, in addition to its action on the cell membrane, in view of its ability to be bound to single-stranded nucleic acids. However, in contrast to previous reports, in our experiments caffeine inhibited RNA synthesis to a greater degree than protein synthesis. The intensification of the action of radiation in irradiated roots is evidently associated with an inhibition of repair processes. (ERB)

IN ANIMALS

4039 (ERDA-tr—51, pp 1-5) **Determination of the molecular weight of single-stranded DNA constituents of irradiated and nonirradiated deoxyribonucleoprotein complexes.** Ryabchenko, N.I.; Golubeva, R.V.; Ivannik, B.P. (Academy of Medical Sciences, Obninsk, USSR). 1975. Translated from Radiobiologiya; 15: No. 2, 171-174(1975).

In Radiobiology.

During the passage of deoxyribonucleoprotein into a solvent containing 0.01 M EDTA + 0.1 M NaOH + 0.9 M NaCl there is a dissociation of the complex and a separation of the strands of DNA. The specific viscosity of the mixture of DNA and protein obtained is determined by molecules of single-stranded DNA, which permits a determination of the intrinsic viscosity of single-stranded DNA without conducting the deproteinization of DNA. A formula relating the intrinsic viscosity of single-stranded DNA in 0.1 M NaOH + 0.9 M NaCl + 0.01 M EDTA to its molecular weight is cited. (tr-auth)

4040 (ERDA-tr—51, pp 113-115) **Stimulation of the incorporation of 1-^{14}C-acetate into the phospholipids of organelles of liver cells of irradiated rats.** Kolomiitseva, I.K.; Kaznacheev, Yu.S. (Academy of sciences of the USSR, Pushchino). 1975. Translated from Radiobiologiya; 15: No. 2, 275-277(1975).

In Radiobiology.

The purpose of the work was an investigation of the incorporation of 1-^{14}C-acetate, which is an index of the turnover of the carbon skeleton of the phospholipids, into the phospholipids of the

substructures of rat liver cells in the normal state and 1 hour after whole-body irradiation at a lethal dose. The results indicate that the synthesis of various parts of the phospholipid molecule occurs at different rates and corresponds unambiguously to the influence of ionizing radiation. (ERB)

RADIATION EFFECTS ON CELLS

EXTERNAL SOURCE

4041 (SSI—1974-028) **Microdosimetry as applied to the study of radiation damage in DNA.** Bengtsson, L.G. (Statens Straalskyddsinstitut, Stockholm (Sweden)). Sep 1974. 22p. (CONF-7409129—1). Dep. NTIS (US Sales Only) $4.25.

From Meeting on space biophysics; Uppsala, Sweden (23 Sep 1974).

This paper presents preliminary attempts at relating the microscopic distribution of energy deposited in irradiated objects to biological effects where DNA damage and its repair may be significant. A short review is given of charged particle track structure, and the significance of energy deposition straggling is discussed. It is shown that the relation between microscopic energy deposition and inactivation of bacterial spores, bacteria, and mammalian cells is the same for heavy charged particles and gamma rays, apart from an approximately constant factor by which the heavy charged particles are more efficient in producing inactivation. This factor goes from 1 for bacteria to 13 for bacterial spores with H_2S available, and its value may be of interest for considerations of the combined mechanisms of radiation damage and repair. The energy deposited seemed more suitable for the description than energy per unit mass or length. The microscopic energy distribution may, with some limited assumptions, permit estimates of the likelihood of a linear dose-response relationship at low doses. Microdosimetry is finally used to show that the synchrony between heavy charged particles and gamma rays seems to hold also when threshold effects show up. The threshold effects consistent with published biological data seem to be large for mutations due to chromosome breaks in maize seeds, moderate for the formation of dicentrics in mammalian lymphocytes and small or non-existent for mutations in Tradescantia stamen hairs. Further studies along the lines drawn up in the paper should be indicated. (auth)

4042 (ERDA-tr—51, pp 57-62) **Investigation of the mechanism of the radiosensitizing action of small doses of ionizing radiation in a culture of HeLa cells.** Kalendo, G.S.; Zhurbitskaya, V.A. (Academy of Medical Sciences USSR, Moscow). 1975. Translated from Radiobiologiya; 15: No. 2, 222-227(1975).

In Radiobiology.

The sensitizing effects of preliminary irradiation (2-3 min before the basic dose of 490 rad) at a dose of 10 rad on a culture of HeLa cells was investigated. It was detected that an originally total dose, separated in this way, leads to the same stimulating effect as a dose of 10 rad. The inhibiting action of the basic dose is manifested only after 1.5 to 2 hrs. The results obtained on the radiosensitizing action of preliminary irradiation at a dose of 10 rad can be explained by delay of the complex of adaptive responses. An analysis of the dose curve showed that preliminary irradiation at a dose of 10 rad causes a decrease in the repair processes. (tr-auth)

4043 (ERDA-tr—51, pp 116-119) **Postradiation modification of radiation damage to SOC cells by natural and synthetic porphyrins.** Yartsev, E.I.; Novosel'tseva, S.D.; Kirillova, G.V.; Ponomarev, G.V.; Yarshunskii, V.G.; Goryacheva, V.N. 1975. Translated from Radiobiologiya; 15: No. 2, 277-280(1975).

In Radiobiology.

The influence of various porphyrins and their metallocomplexes on the postradiation survival of a culture of SOC cells, as well as the interrelationship between the radioprotective effectiveness, chemical structure of the tested porphyrins and the presence of metals in the molecule: Cu^{2+}, Zn^{2+}, Fe^{2+}, Mn^{2+}, and Co^{2+} was studied. It was found that the introduction of a metal into the porphyrin ring leads to changes in the radioprotective properties of the compound. From the data cited it follows that the radioprotective action of the investigated compounds depends on their chemical structure. The introduction of various substituents or metals into the porphyrin ring may substantially change the biological properties of these compounds. (ERB)

4044 **Conditioned medium from plateau-phase cells.** Horowiz, I.A.; Norwint, H.; Hall, E.J.; Phil, D. (Columbia Univ., New York). *Radiology*; **114**: No. 3, 723-726(Mar 1975).

In vitro cell cultures grown into plateau phase may be more suitable than exponentially growing cells as a model for tumor cell growth in vivo. Conditioned medium extracted from cells in plateau phase inhibits growth of log-phase cultures of either the same or a different cell line. Attempts to demonstrate that this inhibition is due to a heat-labile diffusible substance have failed. Conditioned medium extracted from plateau-phase cultures was effective in enhancing repair of potentially lethal damage following x irradiation. Cell survival is significantly increased following a six-hour postirradiation culture in conditioned medium as opposed to complete fresh medium. (auth)

RADIATION EFFECTS ON MICROORGANISMS

BASIC STUDIES

4045 **Ultraviolet light-induced responses of an mfd mutant of E. coli B/r having a slow rate of dimer excision.** George, D.L.; Witkin, E.M. (Rutgers—The State Univ., New Brunswick, NJ). *Mutat. Res.*; **28**: 347-354(1975).

A mutant of Escherichia coli B/r designated mfd has drastically reduced ability to exhibit "mutation frequency decline" (MFD) the irreversible loss of potential suppressor mutations which occurs when protein synthesis is briefly inhibited after irradiation with uv. We have found that the initial rate of thymine dimer excision in the mfd mutant is only about one-third that of its mfd+ parent strain after a uv dose of 400 erg/mm². The yield of uv-induced Tyr+ revertants is 4 to 10 times higher in the mfd strain than in the mfd+ strain. This is comparable to the level of uv-mutability in the mfd+ strain in the presence of caffeine, an inhibitor of dimer excision. Uv-mutability, prophage induction and Weigle reactivation of irradiated lambda phage occur to a greater extent at low uv doses (10 to 50 erg/mm²) in the mfd strain compared to the mfd+ strain. We propose that the slow excision repair in the mfd mutant results in a shift in the induction threshold for these uv-inducible functions toward lower uv doses. (auth)

4046 (ERDA-tr—51, pp 52-56) **Study of the lethal action of ionizing radiation on Chlorella cells with various contents of intracellular cysteine.** Kamchatova, I.E.; Zakharov, I.A.; Korolev, V.G.; Gracheva, L.M.; Zheleznyakova, N.Yu. (Leningrad State Univ.). 1975. Translated from Radiobiologiya; 15: No. 2, 218-221(1975).

In Radiobiology.

It was shown in experiments on related strains of Chlorella vulgaris that the content of sulfhydryl groups in cells of feeder mutants exceeds the content of SH groups in the cells of the initial wild-type strain. The radiosensitivity of the mutant forms of Chlorella does not differ from the initial wild-type strain and a revertant isolated from a culture of the mutant strain. Possibly the presence of a high level of sulfhydryl groups in the cell is not the determining factor in its resistance to ionizing radiation. (tr-auth)

4047 (ERDA-tr—51, pp 63-67) **Possible nature of the increased radioresistance of budding yeast cells.** Korogodina, Yu.V.; Nekrasova, I.V.; Petin, V.G.; Graevskii, E.Ya. (Academy of Medical Sciences USSR, Obninsk). 1975. Translated from Radiobiologiya; 15: No. 2, 228-232(1975).

In Radiobiology.

It was shown in experiments on the diploid yeast Saccharomyces ellipsoideus strain Megri 139-B, that budding cells of a 12-hour culture, distinguished by high radioresistance, contain approximately 150 percent more endogenous thiols than more radiosensitive nonbudding cells from a seven-day culture. The authors attribute the increased radioresistance of budding yeast cells to a higher content of endogenous thiols. (tr-auth)

4048 (ERDA-tr—51, pp 82-85) **LHR in Escherichia coli B after UV irradiation.** Simonyan, N.V. (Erevan Physical Inst.). 1975. Translated from Radiobiologiya; 15: No. 2, 247-251(1975).

In Radiobiology.

It was shown that cells of E. coli B, irradiated with uv at various doses, are capable of reproducing under conditions close to those utilized for the study of their postradiation recovery in liquid nonnutrient media (liquid holding recovery—LHR); moreover, uv irradiation stimulates this reproduction. It was concluded that a quantitative evaluation of the reproduction of the bacteria in such media is essential, as a compulsory method in the study of LHR. (tr-auth)

4049 (ERDA-tr—51, pp 124-126) **Peculiarities of the mutagenesis of bacteriophasge T4Br⁺ under the direct and indirect action of gamma radiation.** Yurov, S.S. (Academy of Sciences USSR, Pushchino). 1975. Translated from Radiobiologiya; 15: No. 2, 284-286(1975).

In Radiobiology.

Earlier we demonstrated the lethal and mutagenic action of radiotoxins (RT), formed in γ irradiation of cells of E. coli B, in the case of their infection with nonirradiated bacteriophage T4B. It

was found that the rII mutations of the bacteriophage formed arise chiefly according to the type of transitions. Similar results were obtained on the radiation mutagenesis of E. coli. However, the comparative contribution of the lethal and mutagenic effects remains unknown, as does the molecular mechanism of mutagenesis under the direct and indirect action of radiation. In the case of mutagenesis of bacteriophage in vitro (nonmetabolizing system), the formation of mutations is possible as a result of the direct action of radiation (direct excitation, ionization of DNA in the head of the bacteriophage) — type I of mutagenesis; and the indirect action of radiation on account of the formation of radicals, peroxides, and radiation chemical products of irradiated medium (similar to chemical mutagenesis)--type II of mutagenesis. In this case the use of bacteriophage to study the mechanisms of mutagenesis permits a complete delimitation of these possible pathways of formation of a mutation and the distinguishment of each of them individually. From the literature data it follows that when extracellular bacteriophage is irradiated in broth, the direct action of ionizing radiation predominates, while in the case of irradiation in buffer solution, the indirect effect is also added. (tr-auth)

4050 Deletion map of CYC1 mutants and its correspondence to mutationally altered iso-1-cytochromes c of yeast. Sherman, F.; Jackson, M.; Liebman, S.W.; Schweingruber, A.M.; Stewart, J.W. (Univ. of Rochester, NY). *Genetics;* **81**: No. 1, 51-73(Sep 1975).

Mutants arising spontaneously from sporulated cultures of certain strains of yeast, Saccharomyces cerevisiae, contained deletions of the CYC1 gene which controls the primary structure of iso-1-cytochrome c. At least 60 different kinds of deletions were uncovered among the 104 deletions examined and these ranged in length from those encompassing only two adjacent point mutants to those encompassing at least the entire CYC1 gene. X-ray-induced recombination rates of crosses involving these deletions and cyc1 point mutants resulted in the assignment of 211 point mutants to 47 mutational sites and made it possible to unambiguously order 40 of these 47 sites. Except for one mutant, cyc1-15, there was a strict colinear relationship between the deletion map and the positions of 13 sites that were previously determined by amino acid alterations in iso-1-cytochromes c from intragenic revertants. (auth)

4051 Genetic and physiological characterization of met15 mutants of Saccharomyces cerevisiae: a selective system for forward and reverse mutations. Singh, A.; Sherman, F. (Univ. of Rochester, NY). *Genetics;* **81**: No. 1, 75-97(Sep 1975).

One hundred and thirty-three spontaneous and induced mutants of the met15 locus in Saccharomyces cerevisiae were characterized with respect to temperature sensitivity, osmotic remediability, interallelic complementation, and suppressibility by amber and ochre suppressors. Forty mutants are osmotic remedial; 17 of these, and no others, are also temperature-sensitive. Seven of 133 mutations are suppressible by an amber suppressor and 11 are suppressible by an ochre suppressor. Seventy percent of the mutants exhibited interallelic complementation, suggesting that the functional gene product of the met15 gene is a multimeric protein. Relative map positions of 30 met15 were estimated from the frequencies of x-ray-induced mitotic reversion of various heteroallelic diploids. All complementing nonsense mutations are located near one end of the gene in contrast to other nonsense mutations which span most of the gene, thus relating the direction of translation of the mRNA with respect to the fine-structure map. Recombination studies indicated that two of 30 mutants contained deletions of the entire met15 locus. It was established that a variety of mutational types, including missense, nonsense, and deletions, are recovered with this unique system in which both forward and reverse mutations can be selected on the basis of methyl mercury resistance and methionine requirement of the met15 mutants. (auth)

RADIATION EFFECTS ON PLANTS

BASIC STUDIES

4052 (ERDA-tr—51, pp 165-167) **Change in the radiosensitivity of plants under the influence of growth regulators.** Kryukova, L.M. (Academy of Sciences USSR, Pushchino). 1975. Translated from Radiobiologiya; 15: No. 2, 317-318(1975).

In Radiobiology.

The role of radiation-induced inhibitors in the change in the radiosensitivity of plants was studied in γ-irradiated corn plants. Chlorogenic and caffeic acid in concentrations characteristic of intact plants were used as the natural inhibitors. Extracts from leaves of irradiated black bean plants were used as induced inhibitors. It was found that the inhibitors induced by ionizing radiation, representing oxidized phenolic compounds, participate actively in the metabolism of the plants, and under definite conditions exhibit a protective action, increasing the radioresistance of the plants on account of an inhibition of metabolic processes. (ERB)

APPLICATIONS

4053 (RT/PROT—(75)11) **Results and perspectives of mutagenesis applied to durum wheat.** Bagnara, D. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1975. 80p. Dep. NTIS (US Sales Only) $6.00.

A review is made of the main aspects and problems of mutagenesis applied to the breeding of durum wheat (Triticum turgidum ssp. durum). Features and type of action of ionizing radiations and chemical mutagens are considered; a comparison is also made between the two classes of mutagens, on the basis of results so far achieved. Mention is, then, made of: methods of treatment; parts of plant which can be treated; growing of treated material in segregating generations; data to be successively recorded. Methods of estimation of frequency of mutations and the problem of arising of chimerical tissues, together with its possible overcoming, are also discussed. Examination is made of some special effects of mutagens, namely: induction of translocations; diploidization of polyploids; induction of haploids and aneuploids; genetic analysis of specific loci; induction of male sterility. Finally, results are reviewed, concerning induction and utilization, either as varieties or in cross breeding programs, of mutants for characters of agronomic interest. (auth)

RADIATION EFFECTS ON ANIMALS

MAN

4054 (LA-UR—75-1872) **Dosimetry of pion beams.** Dicello, J.F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 40p. (CONF-751060—1). Dep. NTIS $5.50.

From International particle radiation therapy workshop; Key Biscayne, Florida, USA (1 Oct 1975).

Negative pion beams are probably the most esoteric and most complicated type of radiation which has been suggested for use in clinical radiotherapy. Because of the limited availability of pion beams in the past, even to nuclear physicists, there exist relatively fewer basic data for this modality. Pion dosimetry is discussed. (CH)

4055 (LA-UR—75-1873) **Physical properties of charged particle beams for use in radiotherapy.** Knapp, E.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 20p. (CONF-751060—2). Dep. NTIS $4.50.

From International particle radiation therapy workshop; Key Biscayne, Florida, USA (1 Oct 1975).

The physical properties of the possible charged particle beams used for cancer radiotherapy are reviewed. Each property is discussed for all interesting particles (π, p, α, Ne ion) and the differences are emphasized. This is followed by a short discussion of the several beam delivery systems used in particle therapy today, emphasizing the differences in the problems for the several different radiations, particularly the differences between the accelerated particle beams and those of a secondary nature. Dose calculation techniques are described. (CH)

4056 (ORO—4002-4) **Effects of x-irradiation on the human testis: an electron microscopic cytochemical study. Terminal report, 1969—1974.** Berlin, J.D. (Texas Tech Univ., Lubbock (USA)). 1974. Contract AT(40-1)-4002. 44p. Dep. NTIS $5.00.

Results are reported from studies on the effects of various doses and dose rates of x radiation on the cytology and function of the human testis. Tissue samples from testicular biopsies were examined for changes in the fine structure of the cells and enzyme localization and activity. Data are included on acid phosphatase, thiamine pyrophosphatase, inosine diphosphatase, glucose-6-phosphatase, and adenosine mono- or triphosphatase. The fine structural localization of phosphatases in the normal human testis was also determined. (CH)

4057 (SSI—1974-032) **Close siting of nuclear power plants.** (Statens Straalskyddsinstitut, Stockholm (Sweden)). Nov 1974. 14p. (In Swedish). Dep. NTIS (US Sales Only) $4.00.

The part of the report "Close Siting of Nuclear Power Plants" (Statens Offentliga Utredningar 1974:56) concerning possibilities of radiation damages in the environment after a reactor accident, is discussed. The calculation model used for calculation of consequences of an accident under different meteorological conditions is criticized, as well as the calculation of the number of late radiation damages. The report is also criticized for not having payed enough attention to slight radiation damages in the calculations of total risks. (auth)

4058 (ERDA-tr—51, pp 110-112) **Influence of gamma irradiation on complexes of progesterone with the protein receptor of the nucleus and cytoplasm of cells of the human endometrium.** Mal'tsev, A.V. (Academy of Sciences USSR, Pushchino). 1975. Translated from Radiobiologiya; 15: No. 2, 273-275(1975).

In Radiobiology.

The question of the degree to which complexes of steroids with cytoplasmic and nuclear protein receptors are sensitive to ionizing radiation has not been clarified. In view of this, the state of the progesterone-receptor complexes (PRC) of the human endometrium after γ irradiation was studied. The data show that in the nuclear fraction of the human endometrium, the specific complex of ^{3}H-progesterone with the protein receptor consists of two fractions differing in radiosensitivity. Most likely the PRC of the nuclear fraction of the human endometrium contains three to four or more fractions which are detected using various physicochemical methods. (ERB)

VERTEBRATES

4059 (COO—3017-24) **Leukemogenesis by low-level radiation.** Warren, S.; Gates, O. (New England Deaconess Hospital, Boston, Mass. (USA). Cancer Research Inst.). 1975. 25p. (SM—202/218). Dep. NTIS $4.50.

Intermittent x-radiation administered in three R doses for ten successive weeks to RAP mice did not increase the incidence of leukemia. A total dose of 100 R (10 R weekly) significantly increased the level. A total dose of 300 R (30 R weekly) increased the incidence of leukemia only slightly but not significantly over that induced by the 100 R total dose. The two leukemogenic doses of x-radiation (100 and 300 R) yielded incidences of leukemia comparable to those following mean doses of perinatal gamma exposure at 200 and 1000 rads. However, continuous lifetime exposure of five successive generations to 30 rads was by far more effective than the higher doses of gamma or x-radiation. In these wide discrepancies between leukemogenic effects of equal low doses of gamma and x-radiation, there are two disparate factors; chronic versus intermittent exposure and the populations at risk; young adult mice versus mice exposed from conception to death. (auth)

4060 (ERDA-tr—51) **Radiobiology.** Translation of *Radiobiologiya;* **15**: No. 2, 171-328(1975). 181p. Dep. NTIS $7.60.

Separate abstracts were prepared for 40 of the 41 papers presented in this issue of the translation of Radiobiologiya. The other paper discussed the influence of bone marrow on the number of antibody-producers in a culture of cells from lymph nodes. (ERB)

4061 (ERDA-tr—51, pp 13-17) **Influence of x irradiation on the development of hyperpolarization of cells, the content of adenine nucleotides, and the distribution of sodium and potassium ions.** Frol'kis, V.V. (Academy of Medical Sciences USSR, Kiev). 1975. Translated from Radiobiologiya; 15: No. 2, 181-184(1975).

In Radiobiology.

X irradiation prevents the development of hyperpolarization of muscle and liver cells, induced by hormones (estradiol dipropionate, deoxycorticosterone acetate, and insulin) and blood loss. X irradiation eliminates the redistribution of K^+ and Na^+ induced by hyperpolarizing factors and does not change the content of ATP, ADP, CP, and P/sub i/. It is assumed that the influence of x irradiation on the development of hyperpolarization and on the ionic shifts in this case is exerted through the system of protein biosynthesis. (tr-auth)

4062 (ERDA-tr—51, pp 18-21) **Reaction of the ATPase activity of the cellular structures of the liver to the action of densely and sparsely ionizing radiations.** Andrianov, V.M.; Chebotarev, E.E.; Kulyabko, P.N.; Roiter, I.A. (Academy of Sciences, Ukrainian SSR, Kiev). 1975. Translated from Radiobiologiya; 15: No. 2, 185-188(1975).

In Radiobiology.

Whole-body irradiation of animals with fast neutrons and x rays disrupts the ATPase activity in liver tissues. The difference in the action of these types of ionizing radiations lies in the fact that during the first hours after irradiation with fast neutrons, the ATPase activity is suppressed chiefly in the nuclei of the hepatocyte, and after x irradiation in the cytoplasm. (tr-auth)

4063 (ERDA-tr—51, pp 26-29) **Factors controlling the recirculation of stem cells. Communication 2. Influence of ACTH on the migration of hematogenic stem cells from a shielded portion of the bone marrow in irradiated mice.** Bezin, G.I.; Khaitov, R.M.; Moroz, V.V.; Petrov, R.V.; Romashko, O.O. 1975. Translated from Radiobiologiya; 15: No. 2, 193-196(1975).

In Radiobiology.

A two-fold decrease in the yield of colonies in the spleen was detected in lethally irradiated (800 R) mice with partial shielding of the bone marrow, which received large doses of long-action ACTH twice after irradiation. The administration of ACTH after whole-body irradiation at a dose of 600 R had no influence on endogenous colony formation. The results obtained are interpreted as a suppression of the emigration of stem cells out of the protected bone marrow under the influence of a high level of corticosterone in the blood plasma, observed after the injection of ACTH. (tr-auth)

4064 (ERDA-tr—51, pp 30-35) **Determination of the number and radiosensitivity of bone marrow cells forming erythroid, myeloid, and megakaryocytic types of colonies in the spleen.** Shvets, V.N.; Chertkov, K.S.; Seslavina, L.S. 1975. Translated from Radiobiologiya; 15: No. 2, 197-201(1975).

In Radiobiology.

Syngenic transplantation of intact or irradiated bone marrow cells increases the number of microcolonies 2 to 3-fold in comparison with macrocolonies. The number of macro- and microscopically detectable colonies is a linear function of the number of cells transplanted and an exponential function of the irradiation dose. The ratio and radiosensitivity of the bone marrow cells forming erythroid, myeloid, and megakaryocytic type colonies proved to be somewhat different. (tr-auth)

4065 (ERDA-tr—51, pp 36-40) **Some results of a mathematical model study of the dynamics of postradiation recovery of hemopoietic tissue.** Monichev, A.Ya.; Gruzdev, G.P. (Inst. of Biophysics, Moscow). 1975. Translated from Radiobiologiya; 15: No. 2, 202-206(1975).

In Radiobiology.

A mathematical model is proposed for the recovery of hemopoietic tissue at the level of stem cells, considering their migration in the animal organism. The principles of the recovery of hemopoietic tissue in the case of various doses of total body irradiation, as well as nonuniform irradiation, were analyzed on the basis of the model. (tr-auth)

4066 (ERDA-tr—51, pp 46-51) **Influence of the dose rate of the gamma rays of ^{60}Co on the colony-forming cells of the mouse bone marrow.** Shvets, V.N. 1975. Translated from Radiobiologiya; 15: No. 2, 212-217(1975).

In Radiobiology.

In the case of irradiation of mice at dose rates from 300 R to 50 R/day, two fractions of CFU, differing in radiosensitivity, are detected in the bone marrow of the animals. In the case of irradiation at a dose rate of 300 R/min to 50 R/day, the fraction of radiosensitive cells is 80 to 100 percent. Their number decreases with decreasing dose rate. The values of ED_{50} and D_0 for the radiosensitive fraction of CFU proved similar and did not depend on the dose rate. The fraction of radioresistant cells increases with decreasing dose rate, comprising 1.4 to 20 percent. ED_{50} and D_0 for this fraction decreased several-fold. (tr-auth)

4067 (ERDA-tr—51, pp 68-72) **Radiation damage to a tissue-equivalent medium on account of elastic collisions in irradiation with protons with initial energies 0.2 to 100 keV and with 1 to 1000 keV neutrons.** Naumov, V.A.; Rozin, S.G.; Troitskii, N.A.; Yaroshevich, A.A. (Academy of Sciences Belorussian SSR, Minsk). 1975. Translated from Radiobiologiya; 15: No. 2, 233-237(1975).

In Radiobiology.

The number of light and heavy atoms ejected during elastic collisions of protons with energies 0.2 to 100 KeV with biological tissue and in the case of irradiation with neutrons with initial energies from 1 to 1000 KeV was calculated. The calculations were performed according to a Monte Carlo method, simulating the processes of interaction of charged particles with the substance, on a system of Minsk-22 electronic computers. In view of the numerous approximations, the results are rough; nonetheless they can be used to interpret the primary lesions induced by the recoil protons. (tr-auth)

4068 (ERDA-tr—51, pp 73-77) **Testing of the activity of plant radiotoxins as allergens for skin tests in irradiated animals.** Kuzin, A.M.; Klemparskaya, N.N.; Kryukova, L.M.; Isichenko, I.B.; Shikhodyrov, V.V. (Academy of Sciences USSR, Pushchino). 1975. Translated from Radiobiologiya; 15: No. 2, 238-243(1975).

In Radiobiology.

The development of processes of autosensitization in irradiated animals was studied by the method of the intracutaneous test—the labial reaction (LR). An investigation of the LR of normal and irradiated (700 R) mice to intracutaneous injection of preparations from plant tissue irradiated at a dose of 25 kR (RT) and nonirradiated (NRT) plant tissue was conducted. It was shown that irradiated animals differ sharply from nonirradiated animals in

the LR when they are administered RT. NRT and distilled water also induce the investigated reaction, but to a substantially lesser degree. The dynamics of the reaction was followed at various time intervals after irradiation, according to various degrees of formation of the autoimmune response. (tr-auth)

4069 (ERDA-tr—51, pp 102-105) **Phosphorolysis and deoxyribosyltransferase reactions of thymidine and deoxyuridine in the organs of irradiated rats.** Mikhailov, V.F.; Mazurik, V.K.; Fedorova, T.A. 1975. Translated from Radiobiologiya; 15: No. 2, 266-268(1975).

In Radiobiology.

The purpose of this work was to study the intensity of the phosphorylitic cleavage of deoxyuridine and thymidine, as well as the formation of these deoxyribosides by deoxyribosyltransferase reactions in the liver and organs of hematogenesis of irradiated rats. The high activity of the enzymes studied, as well as the accumulation of free thymidine in the tissues in the decomposition of DNA after irradiation, permit us to assume that the postradiation increase in the content of deoxyuridine in the organism is partly due to its synthesis from thymidine and uracil. An increase in the summary content of thymidine and deoxyuridine in the irradiated organism is not associated with the inhibition of phosphorylase, since their activity in the organs was unchanged after irradiation. (ERB)

4070 (ERDA-tr—51, pp 130-133) **Peculiarities of the restoration of bone marrow hematogenesis in irradiated monkeys.** Novikova, M.I. (Academy of Medical Sciences USSR, Sukhumi). 1975. Translated from Radiobiologiya; 15: No. 2, 289-292(1975).

In Radiobiology.

The purpose of this work was to study the peculiarities of recovery and the periods of normalization of hemopoiesis in Macacus rhesus subjected to a single whole-body γ irradiation at a dose of 560-640 R. The data obtained are evidence that in monkeys injured by ionizing radiation, the repair processes in the organs of hematogenesis develop slowly over a long period of time. (ERB)

4071 (ERDA-tr—51, pp 134-136) **Determination of rosette-forming lymphoid cells after nonuniform irradiation of mice.** Kozhinova, E.V. 1975. Translated from Radiobiologiya; 15: No. 2, 292-295(1975).

In Radiobiology.

The purpose of this work was to study the principles of the migration of rosette-forming cells (RFC) against a background of nonuniform irradiation in mice. The data obtained indicate that cells of the thymus gland and bone marrow, representing either RFC directly on their precessors, which then undergo differentiation, migrate into the spleen. The antigen-fixing ability of the lymphoid cells in the case of joint shielding of part of the bone marrow and the region of the thymus gland approaches the normal leel, which is evidence of participation of the bone marrow and thymus cells in the maintenance of the population of RFC in the nonuniformally irradiated and intact organism. (ERB)

4072 (ERDA-tr—51, pp 141-144) **Influence of the oxygen-vitamin complex on the general and immunological reactivity of the irradiated organism.** Shvanskaya, N.L.; Baran, L.A. (Kiev Scientific Research Roentgenoradiological and Oncological Inst.). 1975. Translated from Radiobiologiya; 15: No. 2, 298-301(1975).

In Radiobiology.

The influence of the oxygen-vitamin complex (OVC) on the general, nonspecific immunological reactivity of the organism was studied using whole-body x-irradiated rats. It was found that the use of OVC improved the general and immunological reactivity in radiation sickness in rats. (ERB)

4073 (ERDA-tr—51, pp 145-147) **Ultrastructural peculiarities of lesions in the hepatocytes of rats irradiated with x rays and fast neutron.** Andrianov, V.M.; Kulyabko, P.N.; Chebotarev, E.E. (Academy of Sciences Ukrainian SSR, Kiev). 1975. Translated from Radiobiologiya; 15: No. 2, 301-303(1975).

In Radiobiology.

Damage to the ultrastructure of liver cells of animals irradiated with fast neutrons and x rays in biologicaly equivalent doses were studied. The experiments were conducted on whole-body irradiated (fast neutrons or x rays) white rats. The results of the investigation show that there are not only quantitative,but also qualitative differences in the response of organisms to the action of densely and sparsely ionizing radiations. The data agree with previous conclusions that chiefly the structures of the cell nucleus are damaged under the action of densely ionizing radiation, while sparsely ionizing radiations damage primarily the cytoplasm. (ERB)

4074 (ERDA-tr—51, pp 148-150) **Effects of local irradiation of a tumor on the level of thiols in the membrane structures of the liver.** Glushchenko, N.N.; Danilov, V.S. (Moscow State Univ.). 1975. Translated from Radiobiologiya; 15: No. 2, 304-306(1975).

In Radiobiology.

The content of thiol groups in the organelles of the cells, as a result of the high differentiation of which, unity and directedness of the biochemical reactions are ensured during the development of the tumor and the action of radiation therapy was studied. The data obtained are evidence of a substantial disruption of the content of thiols in the membrane structures of the tissue. The intensification of tumor growth found on the fourth day after a single irradiation caused a sharp decrease in the level of thiols in the investigated membrane structures. (EBR)

4075 (ERDA-tr—51, pp 151-154) **Determination of ^{3}H-mexamine in the organism and in liver cells of mice.** Pavlova, L.M.; Sverdlov, A.G.; Grachev, S.A.; Bagiyan, G.A. (Accademy of Sciences, Leningrad). 1975. Translated from Radiobiologiya; 15: No. 2, 306-308(1975).

In Radiobiology.

The distribution of mexamine in the mouse, the penetration of the preparaton into the cell, and its distribution within the cell were studied. The results of experiments studying the distribution of mexamine among the organs of mice showed that 20 min after intraperitoneal injection, the protector is accumulated primarily in the liver and kidneys. The negligible content of the preparation in the spleen may indicate a disruption of the blood supply of this organ, since when mice are given sulfur-containing radioprotectors, which do not exhibit a vasoconstrictive action, the sulfur content in the spleen far exceeds a uniform distribution (250 to 280 percent). The data that we obtained on the small content of mexamine in the mouse spleen agree with other data on the smaller sorption of neutral red in this organ after the introduction of mexamine as a result of spasm of the vessels that it induces. Noteworthy is the high content of tritium in the gonads of the mice 20 min after the introduction of the preparation. By this time, up to 214 percent of the label is accumulated in the testes, evidently belonging to the unchanged preparation, which may be of definite significance in the protection of the testes in these animals. Thus, the data cited are indirect evidence in support not only of vascular, but also of cellular mechanisms of the action of mexamine in the integral organism.

4076 (ERDA-tr—51, pp 155-156) **Kinetics of the immune response in nonuniformly irradiated (shielding of the thymus gland and part of the bone marrow) mice of different lines.** Batyrbekov, A.A. 1975. Translated from Radiobiologiya; 15: No. 2, 309-310(1975).

In Radiobiology.

An attempt was made to strengthen the immune response of nonuniformly irradiated mice with shielding of part of the bone marrow source of β-lymphocytes by means of simultaneous protection of the thymus gland (source of T-lymphocytes). The interaction of cells of the bone marrow and thymus gland in the case of their joint shielding was manifested to different degrees depending on the genotype. It was concluded that the genetically determined differences between the mice of the CBA live (high-reactivity) and the mice of the C57BL/6 line (low reactivity) are associated with cooperative interactions between the T and B lymphocytes, expressed to different degrees, upon which the different intensity of the migration of β-lymphocytes from the bone marrow or T-lymphocytes from the thymus gland may be based. (ERB)

4077 (ERDA-tr—51, pp 157-158) **Influence of reverse anaphylaxis on the survival of irradiated mice.** Ivanov, A.A.; Andrianova, I.E. 1975. Translated from Radiobiologiya; 15: No. 2, 311-312(1975).

In Radiobiology.

An analysis of the literature data on the clinical manifestation of anaphylaxis and the primary response to irradiation, as well as our immunological analysis of the primary response to irradiation, have made it possible to suggest a generality of the mechanisms of the development of these phenomena. It is known that decomplementing agents suppress the development of anaphylactic shock. On the basis of this, in the present work we made an attempt to change the levels of the primary response to irradiation and increase the survival of irradiated animals by lowering the level of complement in the serum, achievable by reverse anaphylaxis. Earlier therapeutic effect of a resolving injection of antigen in anaphylactic shock, performed immediately after irradiation, was established. However, sensitization before irradiation may change the reactivity of animals and their resistance to irradiation; therefore, in the work we used the method of reverse anaphylaxis, which does not require preliminary sensitization. It was found that an influence leading to a decrease in the level of complement without preliminary (before irradiation) change in the immunological status of the sensitization for the active development of anaphylaxis, increased the survival of irradiated animals. (ERB)

4078 (ERDA-tr—51, pp 161-164) **Dependence of the change in the dynamics of the water mtabolism in the rabbit organism on the dose of external γ radiation.** Romanovskaya, L.L.; Bogdanov, K.M.; Filatov, P.P.; Kazanina, G.A. (Academy of Medical Sciences USSR, Obninsk). 1975. Translated from Radiobiologiya; 15: No. 2, 314-317(1975).

In Radiobiology.

A study and mathematical description of the dependence of the change in the dynamics of the water metabolism in rabbits on the dose of external γ radiation was undertaken using tritiated water. In the work they detected and described the dependence of the half elimination constant of the isotope on the dose of irradiation, which is exponential. The quantitative ratios obtained, characterizing the degree of disruption of the dynamics of the water metabolism, expressed in terms of the ratio of the biological half-lives to the half-elimination constant, were obtained; in the comparative series control: R:600 R:900 R they have values of 15:21:32:47, respectively.

INVERTEBRATES

4079 **Genetic damage at specific gene loci in Drosophila with betatron x-rays.** Alexander, M.L. (Southwest Texas State Univ., San Marcos). *Genetics;* **81**: No. 3, 493-500(Nov 1975).

The mutation rate was determined for mature sperm at eight specific gene loci on the third chromosome of Drosophila melanogaster using the low ion density radiations of 22 MeV betatron x rays. A dose of 3000 rads of betatron x rays produced a mutation rate of 4.36 x 10^{-8} per rad/locus. Among the mutations observed, 66 percent were recessive lethals and 34 percent viable when homozygous. Only one of the 24 viable mutations was associated with a chromosome aberration. Among the 47 recessive lethals, no two-break aberrations were detected in 48.9 percent of the lethals, deletions were associated with 42.2 percent, inversions with 6.7 percent and translocations with 2.2 percent. When these genetic results are compared to those for 250 KV x rays, the mutation rate for betatron treatments was slightly lower (.76), the recessive lethal rate among induced mutations was higher, and the chromosome aberrations among lethal mutations were slightly lower than with 250 KV x rays. Although the two types of irradiations differ by an ion density of approximately ten, the amount and types of inheritable genetic damage induced by the two radiations in mature sperm were not significantly different. (auth)

BASIC STUDIES

4080 (ERDA-tr—51, pp 127-129) **Analysis of the nature of fluctuations in the radioresistance of the sea urchin during early embryogenesis.** Konstantinova, M.M.; Tarasenko, A.G.; Nekrasova, I.V.; Dontsova, G.V. (Academy of Sciences USSR, Moscow). 1975. Translated from Radiobiologiya; 15: No. 2, 286-288(1975).

In Radiobiology.

An analysis of the relationship of the radiosensitivity of sea urchin eggs to the level of endogenous thiols in them in the course of the division of cleavage using modification of radiation damage was conducted. The radioprotective effect of various concentrations of MEA on the phase of mitosis differing most in their sensitivity to thiol content (metaphase and telophase) was also investigated. Also, the effectiveness of the radioprotective action of MEA on cells of other stages of the cell cycle and characterized by different contents of SH groups was determined. It was concluded that although thiols play only a secondary role in determining the nature of the radiosensitivity, in the case of the physiological change in the state of the cell (various stages of mitosis) they play a determining role. It was also shown that the radioresistance of the cells can be increased at both stages of mitosis with the aid of radioprotectors. (ERB)

RADIONUCLIDE EFFECTS - INTERNAL SOURCE

MAN

4081 (ORNL—5000(Pt.2)) **Tabulation of dose equivalent per microcurie-day for source and target organs of an adult for various radionuclides.** Snyder, W.S.; Ford, M.R.; Warner, G.G.; Watson, S.B. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 441p. Dep. NTIS $10.60.

Data are tabulated on the radiation dose equivalent per microcurie-day for source and target organs of a human adult for 100 radionuclides. These are listed at the end of the volume. Included are several radionuclides where the parent has a daughter radionuclide of physical half-life less than five minutes. In such cases separate S tables are given for the parent and for the daughter as well as a composite table which contains S values for the parent plus S values for the daughter weighted according to the percent decay via the daughter. (CH)

ANIMALS

4082 (ERDA-tr—51, pp 41-45) **Change in the values of certain biochemical indices of the blood after the introduction of radioactive isotopes.** Zapol'skaya, N.A.; Fedorova, A.V. (Leningrad Scientific Research Inst. of Radiation Hygiene). 1975. Translated from Radiobiologiya; 15: No. 2, 207-211(1975).

In Radiobiology.

The change in certain biochemical indices arising in the blood during chronic peroral intake of strontium-90, cesium-137, and iodine-131, in amounts leading to the accumulation of commensurate doses in the corresponding critical organs for each isotope, was studied. (tr-auth)

4083 (ERDA-tr—51, pp 78-81) **Study and comparative evaluation of radiation lesions and recovery processes in the large intestine under the influence of radionuclides of the rare earth group.** Lavrent'ev, L.N. (Leningrad Scientific Research Inst. of Radiation Hygiene). 1975. Translated from Radiobiologiya; 15: No. 2, 244-246(1975).

In Radiobiology.

In the case of prolonged chronic irradiation of tissues of the large intestine of rats with various types of β emitters, a definite relationship was noted between the tissue doses, the injurious effects, and the nature of the recovery. The indicated pattern was influenced by the dose rate. Among the factors maintaining the prolonged course of inflammatory and recovery processes, changes in the blood vessels and the introduction of microbial flora into the necrotized parts of the mucosa were detected. (tr-auth)

4084 (ERDA-tr—51, pp 91-95) **Some indices of the immunologic reactivity in dogs in the long-term periods after administration of polonium.** Shal'nova, G.A.; Kuz'mina, T.D.; Mikhailovich, S.M. 1975. Translated from Radiobiologiya; 15: No. 2, 256-259(1975).

In Radiobiology.

In dogs treated with polonium-210 (2.5 μCi/kg) and surviving as a result of treatment with oxathiol, seven years after the administration of the isotope a disturbance of the factors of natural immunity (quantitative and qualitative composition of the microflora and bactericidal properties of the skin and oral mucosa, phagocytic activity of the blood neutrophils) and the presence of an autoimmune state (a positive Hoigne reaction and reaction of leukocyte agglomeration) was detected. (tr-auth)

4085 (ERDA-tr—51, pp 159-160) **State of the progeny of female rats treated with plutonium-239.** Ovcharenko, E.P.; Nifatov, A.P. 1975. Translated from Radiobiologiya; 15: No. 2, 312-314(1975).

In Radiobiology.

The comprehensive development of the problem of the influence of ionizing radiation on the progeny requires the accumulation of knowledge of the influence of the most practically important radioactive isotopes. The successful work of domestic and foreign researchers along this line has as yet pertained only to a definite degree to the transuranium elements. Therefore, information on the substantial death of the progeny of animals treated with ^{239}Pu is stimulating a comprehesive study of the question. The sensitivity of the experimental baby rates of litter I at one month of age to intraperitoneal injection of ^{239}Pu citrate in amounts from 10 to 80 μCi/kg did not differ from the control. The response to the administration of subacute-toxic amounts of ^{239}Pu to the experimental progeny is analogous to that found earlier for ^{241}Am. The administration of the chronialy effective amount of ^{239}Pu (0.004 μCi/g) to female rats had no influence on the weights, physical development, and peripheral blood of the baby rats and on their sensitivity to the supplementary administration of subacute-toxic amounts of ^{239}Pu. (ERB)

NUCLIDE KINETICS AND TOXICOLOGY

4086 (BNWL-SA—5360) **Considerations in developing a work place standard for sampling airborne uranium.** Schwendiman, L.C.; Andersen, B.V.; Selby, J.M.; Waite, D.A. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Apr 1975. 17p. (CONF-750445—8). Dep. NTIS $4.00.

From Conference on occupational health experience with uranium; Arlington, Virginia, USA (28 Apr 1975).

Developing a comprehensive standard for sampling airborne particulate uranium compounds in work areas requires an awareness of many technical and regulatory considerations. This paper calls attention to regulations, analytical requirements, and provides some observations relating to the mechanics of sampling in the work areas. Regulatory requirements specify the need for exposure control through representative airborne sampling, yet in the case

of uranium, bioassay is the more definitive method of evaluating personnel exposure. This consideration will influence the degree of sophistication in the air sampling program. The sampling standard should address the question of fixed vs. personal samplers, and how each should be used. Writing a standard for uranium in the nuclear fuel cycle presents a challenge and must resolve different viewpoints. (auth)

MAN

4087 (HW—44341) **Distribution of plutonium observed in human blood.** Wilson, R.H. (General Electric Co., Richland, Wash. (USA). Hanford Atomic Products Operation). 30 Jun 1956. 6p. Dep. NTIS $4.50.

The distribution and retention of plutonium in the blood system of nine individuals was studied following uptake by inhalation or through puncture. The results obtained indicate definitely that the blood content was much higher than would be predicted by analysis of urine samples obtained during the first few months after intake. They also indicated the possibility of material being slowly released to the blood from a source at the site of entry, to be subsequently deposited in the skeleton. (CH)

ANIMALS

4088 (CONF-751043—4) **Studies directed toward improving the spatial resolution of the distribution of plutonium in bone.** Auxier, J.A.; Beach, J.L.; Becker, K.; Gammage, R.D.; Henley, L.C.; Parkinson, W.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 24p. Dep. NTIS $4.50.

From Workshop on the biological effects and toxicity of Pu 239 and Ra 226; Sun Valley, Idaho, USA (6 Oct 1975).

Of several methods which have been discussed for the improvement of resolution in fission fragment track detectors for neutron-induced autoradiography, emphasis had been on the use of absorber layers inserted between the sample and the detector. Scanning electron microscopy was shown to be beneficial for viewing only the entrance holes of fission fragment tracks in the detector foil. The primary disadvantage of using thick absorbers lies in the factor of 50 to 100 percent loss in sensitivity over bare detectors. One promising solution to this problem is the use of glass detectors with high critical angles, no absorbers, and short etching times. Such detectors gave the best resolution of any system tested (+-2 μ), though they suffered at fluences greater than 10^{16} n/sub th/ cm^2 from high backgrounds as a result of their natural uranium content. Two samples of bone, each of 1 mg were dissolved in HNO_3 spiked with ^{244}Pu, and analyzed for total ^{239}Pu content in an isotopic abundance mass spectrometer. The ^{239}Pu concentration was 1 ppm by weight; bones with 10 ppm of ^{239}Pu are required, therefore, for neutron-induced autoradiography. Bones in suitable form for IMMA required only to be coated with a thin conductive coating of gold. In a fast scan mode, all elements were searched in 200 x 200 areas. Good quality micrographs were obtained showing Na, K, Ca, and P as major constituents with minor elements present, such as Cr and Fe. (CH)

4089 (ERDA-tr—51, pp 86-90) **Metabolism and acceleration of the elimination of americium-241 from the organism after inhalation of the isotope.** Il'in, L.A.; Popov, B.A.; Zalikin, G.A.; Skomorokhova, T.N.; Borisov, V.P.; Semenov, A.I. 1975. Translated from Radiobiologiya; 15: No. 2, 252-255(1975).

In Radiobiology.

In experiments on noninbred white rats with inhalation of americium-241, it was shown that the basic organs of deposition of the radionuclide are the lungs—23.1 percent, the liver—6.3 percent, and the skeleton—2.9 percent (of the inhaled amount). The effectiveness of the treatment of animals with DTPA depends on the mode of administration. Administration of DTPA by inhalation (10 μM) has the same effect as parenteral introduction of 100 μM and per os administration of 500 μM. (tr-auth)

4090 (ERDA-tr—51, pp 96-101) **Some data on the microdistribution and pathological anatomy of curium-244.** Rudnitskaya, E.I.; Moskalev, Yu.I. 1975. Translated from Radiobiologiya; 15: No. 2, 260-265(1975).

In Radiobiology.

The work presents data on the microdistribution and pathological anatomical changes in the organs and tissues of rats subjected to a single intravenous injection of $CmCl_3$ (pH 3.0) up to 200 days before the beginning of the experiment. A dose of 0.2 to 0.1 μCi/g causes death of the experimental animals with a picture of acute radiation sickness, regardless of the period of death; some individuals survive up to 123 to 160 days after the beginning of the experiment at a dose of 0.1 μCi/g. Doses of 0.025, 0.01, 0.0025, and 0.001 μCi/g also produce specific changes, but less pronounced. In the bone, liver, kidneys, and cardiac muscle, by the end of the first day, aggregated particles of ^{244}Cm are detected. The most severe morphological changes develop in the hematogenic tissue, contained in the bony skeleton, and in the liver. (tr-auth)

PLANTS

4091 (BNWL-SA—5389) **Fate of plutonium intercepted by leaf surfaces: leachability and translocation to seed and root tissues.** Cataldo, D.A.; Klepper, E.L.; Craig, D.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 17p. (CONF-751105—15; SM—199/60). Dep. NTIS $4.50.

From IAEA international symposium on transuranium nuclides in the environment; San Francisco, California, USA (17 Nov 1975).

A low windspeed plant exposure chamber was employed for the generation and deposition of particulate ^{239}Pu as nitrate, citrate, and oxide (fresh and aged) onto foliage of Phaseolus vulgaris. Physical deposition characteristics and particle sizing were routinely measured and deposition parameters calculated. At wind speeds of 0.42 cm sec^{-1}, deposition velocities for these compounds were of the order 10^{-3} cm sec^{-1} with deposition rates onto exposed foliage of 0.26 to 0.52 pg ^{239}Pu cm^{-2} sec^{-1}. The fate of surface deposited Pu compounds with respect to chemical modification and leachability was evaluated by leaching with synthetic rainwater and 0.1 percent HNO_3 solutions. Leaching of contaminated foliage with acidified solutions resulted in a 1-to-9 fold increase in Pu removal from foliar surfaces, depending upon chemical form, as compared to rainwater. Sequential leaching of foliage at 1, 7, 14, or 21 days after contamination indicated a reduced leachability of surface deposits with residence time on the leaf. The extent of leaching and concentration of soluble component was dependent on chemical form supplied (Pu-citrate greater than -nitrate greater than -aged oxide greater than -fresh oxide). The bioavailability of Pu as measured by translocation of foliarly deposited plutonium to root and seed tissue was markedly affected by the presence of a solution vector (i.e., simulated rainfall), and also the timing of its application. (auth)

THERMAL EFFECTS

INVERTEBRATES

4092 (BNWL-SA—5435) **Direct effects of cold shock: bioassays with three Columbia River organisms.** Becker, C.D.; Schneider, M.J. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 19p. (CONF-750985—5). Dep. NTIS $4.50.

From 15. Hanford life sciences symposium; Richland, Washington, USA (25 Sep 1975).

Results of studies of the direct effects of cold shock on the pumpkinseed sunfish (representing a warmwater fish), the rainbow trout (representing a coldwater fish), and the common crayfish showed that resistance to cold shock varies between species, is dependent on acclimation temperature, and resistance to temperature declines is dependent on the decline rate. Severe cold shock at a sublethal level is accompanied by disorientation, loss of equilibrium, and immobilization. Pumpkinseed, the warm water species, are most susceptible. Rainbow, the cold water species, are less susceptible; at an acclimation 10°C, rainbow survive abrupt shock to levels slightly above freezing. Crayfish, the decapod crustacean, are most resistant; at an acclimation of 15°C, crayfish survive abrupt shock to the point just above freezing. (CH)

CHEMICALS METABOLISM AND TOXICITY

PLANTS

4093 (CONF-750929—1) **Trace metals in mangrove seedlings from polluted and unpolluted bays in Puerto Rico.** Banus, M.D. (Puerto Rico Nuclear Center, Mayaguez). 1975. 20p. Dep. NTIS $4.00.

From 15. symposium on the biological implications of metals in the environment; Richland, Washington, USA (29 Sep 1975).

Red mangroves (Rhizophora mangle) propagate by dropping ripe viviparous seedlings into the water surrounding their roots. Nine batches of thirty ripe seedlings, picked from trees in six locations in Puerto Rico where there are increasing amounts of chemical pollution were analyzed for the trace metals Fe, Mn, Cu, Zn, Pb, Ni, and Cd. The leafing (top) and rooting (bottom) ends of each seedling were oven-dried and analyzed by wet-ashing and atomic absorption spectrophotometry. The mean concentration of

tops and bottoms of the thirty seedlings in each batch and between batches were compared using "t" statistics at the 98 percent level. The Cu concentration of seedlings from unpolluted areas is 2.5 ppm with no difference between top and bottom. The concentration increases to 5-7 ppm in locations subjected to pollution. The Fe concentration is 12 ppm for bottom and 13-15 ppm for top of seedlings. Mean values of 21 to 25 ppm were found in some top and bottom of seedlings from polluted areas. From unpolluted estuarine mangroves, Mn was 10 to 11 ppm in bottoms and 30 ppm in tops. The top vs. bottom ratio of Mn was 3 to 4 for all seedlings. Seedlings from an off-shore coral island have 3.7 ppm Mn bottom and 10.3 ppm top. Accurate Zn levels were not possible due to contamination but are estimated to be 20 to 30 ppm. Pb, Cd and Ni were below detection limits. (auth)

OTHER ENVIRONMENTAL POLLUTANT EFFECTS

4094 (NTIS/PS—75/530) **Airport noise. A bibliography with abstracts. Search period covered: 1964—June 1975.** Habercom, G.E. Jr. (National Technical Information Service, Springfield, Va. (USA)). Jun 1975. vp. NTIS $25.00.

The bibliography covers aircraft-created noise, noise intensity, noise exposure, and physiological effects, all in airport environments. (SFL)

HEALTH AND SAFETY

4095 (ORNL-tr—4053) **Radiation genetic effects of electron vacuum tubes of a radar station.** Stykan, O.A. Translated by M. Gerrard from *Voenno-Med. Zh.*; **7**: 36-38(Jul 1967). 4p. Dep. NTIS $4.50.

Results of studies are reported that indicate that in the working areas of a radar station there are sources of soft x radiation whose intensity exceeds the maximum permissible values of dose for the station, but observance of the safety rules will ensure protection of personnel from the action of radiation. Non-compliance with safety rules in regulating and installation of equipment may result in soft x irradiation of personnel. For further insurance of prevention of undesirable effects of radiation on personnel working at a radar station for extended times, direct studies of the chromosomes of the somatic cells should be made by cultivation of leucocytes of the peripheral blood, which permit judging the mutagenic action of different factors on human chromosomes. (auth)

PHYSICS RESEARCH

ASTROPHYSICS AND COSMOLOGY

SOLAR PHENOMENA

4096 **Integrating eclipse optics into the AEC Air Force Flying Laboratory.** Brixner, B. (Los Alamos Scientific Lab., NM). *SPIE Semin. Proc.*; **54**: 27-31(1975).

The Los Alamos Scientific Laboratory (LASL) has participated in five airborne total solar eclipse expeditions designed to measure the temperature, density, structure, motions, and composition of the sun's corona. This information is being gathered as part of a study of the sun's behavior throughout its eleven-year cycle. The advantage of these airborne observations over earthbound ones is that they are made above eighty percent of the atmosphere and its clouds and water vapor. The consequent reduction in atmospheric turbulence, scattered light, and water-vapor absorption greatly improves visibility. Because the plane moves with the eclipse shadow, the time available for making the observations is up to one half longer than a ground observer's time. (auth)

COSMOLOGY

4097 **Class of cosmological models with torsion and spin.** Tafel, J. (Univ., Warsaw). *Acta Phys. Pol., Ser. B*; **B6**: No. 4, 537-554(1975).

Homogeneous models of the universe filled with a spinning fluid are studied in the framework of the Einstein-Cartan theory of gravitation. It is assumed that the models admit a group of motions simply transitive on three-surfaces orthogonal to the world lines of the substratum. For certain group types, the field equations are partially integrated. The models of the Bianchi types I, VII_0, V are shown to be nonsingular, provided the influence of spin exceeds that of shear, and an equation of state satisfies some physically reasonable conditions. (auth)

ATMOSPHERIC PHYSICS

AURORAL AND IONOSPHERIC PHENOMENA

4098 (UCRL—77115) **Properties of auroral-line induced transitions.** Murray, J.R.; Powell, H.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 Aug 1975. 7p. (CONF-750914—5). Dep. NTIS $4.00.

From 2. summer colloquium on electronic transition lasers; Woods Hole, Massachusetts, USA (17 Sep 1975).

The radiation induced near the $O(^1S)$—$O(^1D)$ auroral-line of atomic oxygen by collisions with rare gas atoms has been studied. Emission from both bound, quasi-molecular states and from free atoms perturbed in collisions is observed. Experimental measurements of kinetic rates and their temperature dependences will be presented. (auth)

ATOMIC, MOLECULAR, AND CHEMICAL PHYSICS

BEAMS AND THEIR REACTIONS

4099 (SAND—75-0217) **Program diode and its use in E-beam diagnostics.** Phillips, A.R. (Sandia Labs., Albuquerque, N.Mex. (USA)). Jul 1975. Contract AT(29-1)-789. 56p. Dep. NTIS $5.50.

Typical input data deck structure, the options available to the user, the data processing methods, and the presentation of output are described for the computer program series DIODE. (GHT)

4100 (SAND—75-5490) **Depth profiling of deuterium and helium in metals by elastic proton scattering: a measurement of the enhancement of the elastic scattering cross section over Rutherford scattering cross section.** Langley, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 15p. (CONF-750949—4). Dep. NTIS $4.00.

From International conference on ion beam surface layer analysis; Karlsruhe, F.R. Germany (15 Sep 1975).

Ion backscattering was used to observe deuterium and helium in thin films on thick substrates. With this technique, the elastic scattering cross section for protons on deuterium at 170°C (lab) was found to be approximately 140 times greater than the Rutherford cross section at 2.0 MeV and approximately 260 times greater at 2.8 MeV. For protons incident on ^4He, the elastic cross section is increased over the Rutherford cross section by approximately 300 at 2.8 MeV. A discussion of the experimental setup, results of the measurement of the reaction cross section, a demonstration of the technique on specially-prepared films and a description of an analytical technique to provide impurity concentration vs depth from yield vs energy spectra are given. (6 figures, 13 references) (GHT)

4101 **Diffraction of a thermal atomic beam from a magnetic surface.** Thompson, E.D.; Felcher, G. (Argonne National Lab., IL). *AIP (Am. Inst. Phys.) Conf. Proc.*; No. 24, 394-396(1975).

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

See CONF-741202—.

A thermal energy atomic beam is diffracted from a crystalline surface as from a corrugated hard wall. For an atomic hydrogen beam and a crystalline surface containing magnetic ions, the magnitude of the corrugations is spin dependent. The magnetic part depends on the relative size of the magnetic shell to the atomic radius. The scattering of a thermal energy atomic hydrogen beam from the (001) surface of MnO is calculated and it is found that the antiferromagnetic diffracted intensity is comparable to the specular intensity. Magnetic effects in the scattering from Eu^{++}-containing compounds are negligible. It is concluded that atomic beam scattering is potentially an important new tool for studying the magnetic state of the surface of insulating crystals. (auth)

4102 **Photo-Compton currents emitted from a surface.** Dellin, T.A. (Sandia Labs., Livermore, CA); MacCallum, C.J. *J. Appl. Phys.*; **46**: No. 7, 2924-2934(Jul 1975).

Weymouth's method [Phys. Rev., 84, 766 (1951)] for calculating electron transport in a half-space is generalized and used to obtain algebraic expressions for the magnitude and angular distribution of the photo-Compton current emitted from a surface irradiated by photons of any energy between 10 keV and 10 MeV.

Algebraic expressions for the energy deposition at the surface and for the energy distribution of the emitted electrons are also obtained. Comparisons with Monte Carlo calculations and with experiment are presented. (4 figures, 5 tables) (auth)

4103 Multiple reflections of electrons and the possibility of intense positive-ion flow in high ν/γ diodes. Prono, D.S.; Creedon, J.M.; Smith, I.; Bergstrom, N. (Physics International Company, San Leandro, California 94577). *J. Appl. Phys.*; **46**: No. 8, 3310-3319(Aug 1975).

Variations of the nature and pressure of the background gas used for neutralizing the charge of a relativistic electron beam have been observed to alter the current waveform of the propagating beam, the time delay before propagation begins, and the voltage and current waveforms of the diode which accelerates the beam. This interaction between the beam region and the diode occurs during the delay phase before beam propagation begins and can be explained by (1) the reflection of electrons back into the diode from a virtual cathode which exists in the beam region during the delay phase and (2) the flow of a significant positive-ion current in the diode during this same period. A theory describing positive-ion flow in the presence of multiply reflected electrons is developed and compared to experimental observations.

4104 Recoil contribution to ion-implantation energy-deposition distributions. Brice, D.K. (Sandia Laboratories, Albuquerque, New Mexico 87115). *J. Appl. Phys.*; **46**: No. 8, 3385-3394(Aug 1975).

A previous method for directly calculating the spatial distribution of energy deposition into damage or ionization for ions implanted into solid targets is extended to account for energy transport by recoiling target atoms. The new calculations extend the applicability of the method to lower incident ion energies. In addition, an intermediate step in the calculations provides information on the spectrum of target recoil atoms. Good agreement is obtained between experiment and theory using the improved procedure. Calculated damage energy distributions are presented for 10-keV—1-MeV B, P, As, and Sb ions incident on silicon.

ATOMIC AND MOLECULAR PROPERTIES

4105 (COO—2753-11) **Lifetimes and fluorescence yields of three-electron ions.** Bhalla, C.P.; Gabriel, A.H. (Kansas State Univ., Manhattan (USA); UKAEA Research Group, Abingdon. Culham Lab.). 1975. 7p. (CONF-750975—1). Dep. NTIS $4.00.

From 4. international conference on beam-foil spectroscopy; Gatlinburg, Tennessee, USA (15 Sep 1975).

Theoretical total rates of the various levels for the $1s\,2p^2$, $1s\,2s^2$ and $1s\,2s\,2p$ configurations are presented for atomic numbers 7, 8, 10, 16 and 26. The line fluorescence yields for these cases are also listed. (auth)

4106 Phosphorescence-microwave multiple resonance spectrosopy. El-Sayed, M.A. (Univ. of California, Los Angeles). *Advan. Photochem.*; **9**: 311-367(1974).

A survey of studies performed prior to 1974 is given. The basic principles and equations of phosphorescence microwave multiple resonance (PMDR) spectroscopy methods are discussed, followed by a description of the experimental methods. The application of PMDR spectroscopy to magnetic studies, optical and structural spectroscopy, and nonradiative processes involving the triplet state are summarized and discussed. (98 refs) (GHT)

4107 Spectroscopic flame temperature measurements and their physical significance. III. Existence of isothermal zones in some laboratory flames. Reif, I.; Fassel, V.A.; Kniseley, R.N. (Ames Lab., IA). *Spectrochim. Acta, Part B*; **30B**: 163-168(1975).

For the accurate measurement of certain atomic and molecular properties, such as absolute or relative transition probabilities, dissociation energies, and optical cross sections, it is desirable to form and observe atoms and molecules in an isothermal environment whose temperature can be measured precisely. It is shown that a premixed N_2O-C_2H_2 flame burning on a long path, slot burner can provide not only a relatively high temperature (~3000 K) but also an isothermal environment as well. In this flame, well-developed atomic emission spectra of all the metallic elements may be readily observed. This flame and burner system should therefore be useful for the determination of more accurate relative transition probabilities for many elements. (4 tables) (auth)

4108 First period transition metal sulfide gaseous molecules: matrix spectra, oxide—sulfide correlation, and trends. DeVore, T.C.; Franzen, H.F. (Ames Lab., IA). Contract W-7405-eng-82. *High Temp. Sci.*; **7**: 220-235(1975).

Infrared spectra for the gaseous monosulfides of Ti, V, Cr, Mn, Fe, and Ni and electronic transitions for the gaseous monosulfides of V, Cr, and Fe were observed in Ar and OCS matrices. All infrared frequencies were observed between 500 and 600 cm^{-1}. The sulfide force constants (K/sub ms/) were found to be related to those of the isoelectronic oxide (K/sub mo/) by the equation, D/sub mo/K/sub ms//D/sub ms/K/sub mo/ ≈ 0.769, where D is the dissociation energy. A schematic MO diagram is presented which explains the observed trends in the dissociation energies and the force constants. (13 figures, 10 tables) (auth)

4109 Nonstatistical emission from metastable autoionizing states of OI. Dehmer, P.M.; Chupka, W.A. (Argonne National Lab., IL). *J. Chem. Phys.*; **62**: No. 2, 584-591(15 Jan 1975).

Emission intensities are reported for multiplet components of three metastable autoionizing OI $^3P^0$ levels with nanosecond lifetimes--the $2s2p^5\ ^3P^0$, $3s''\ ^3P^0$, and $3d'\ ^3P^0$ states. Emission intensities for the $3s''\ ^3P^0$ and $3d'\ ^3P^0$ states are nonstatistical, i.e., the observed intensities for components of the multiplets do not correspond to the theoretical statistical absorption intensities. Autoionization, prohibited for these states in a pure Russel--Saunders coupling scheme, proceeds via weaker spin-orbit or spin-spin interactions, primarily through direct interaction with available continua. Previous autoionization studies of all these states showed that the autoionization intensities are nonstatistical only for the $2s2p^5\ ^3P^0$ and $3s''\ ^3P^0$ states. These results are explained in terms of a competition between autoionization and emission based on a comparison of the true lifetimes of the states and the radiative lifetimes calculated from the absorption oscillator strengths. When the autoionization and emission lifetimes are comparable, both decay channels show nonstatistical behavior; when one decay channel dominates, only the minor decay channel shows nonstatistical behavior. The nonstatistical nature of the decay is discussed in terms of selective autoionization of certain total angular momentum levels of the decaying $^3P^0$ states; however, additional theoretical work is required to establish the origin of this effect. (5 fig, 4 tables, 16 refs) (auth)

4110 Correlation of vibrational broadening of core lines in x-ray photoelectron spectra with valence bond resonance structures. Jolly, W.L.; Schaaf, T.F. (Univ. of California, Berkeley). *Chem. Phys. Lett.*; **33**: No. 2, 254-256(1 Jun 1975).

When core ionization of an atom in a molecule causes significant changes in bond orders, the core-hole ion is formed in a strained configuration. This strain causes vibrational broadening of the core line. The core-hole ion can be represented as an ordinary chemical species by applying the equivalent cores approximation. Then simple rules of classical valence bond theory can be used to predict changes in the weighting of resonance structures and corresponding changes in bond orders. Thus, qualitative changes in relative linewidths can be predicted. (12 refs) (auth)

4111 Nonadiabatic effects on vibronic intensities of larger polyatomic molecules in the preresonance regime. Small, G.J. (Ames Lab., IA). *J. Chem. Phys.*; **62**: No. 12, 4661-4666(15 Jun 1975).

The approximations used to simplify the perturbation-based theory of nonadiabatic interactions and their effects on vibronic intensities in the preresonance regime are examined for the larger polyatomic molecules. They include employment of a crude adiabatic basis set and certain approximate sum rules. (4 tables) (auth)

4112 Systematics of moments of dipole oscillator-strength distributions for atoms of the first and second row. Dehmer, J.L.; Inokuti, M.; Saxon, R.P. (Argonne National Laboratory, Argonne, Illinois 60439). *Phys. Rev. A*; **12**: No. 1, 102-121(Jul 1975).

The moments $S(\mu)$ and $L(\mu) = dS(\mu)/d\mu$ for -6 less than or equal to μ less than or equal to 1 are derived from comprehensive Hartree-Slater oscillator-stength distributions for He through Ar. For μ less than or equal to -2, these moments are governed by valence excitations only, and therefore exhibit a pronounced periodic variation that repeats in each row. Inner shells begin to contribute appreciably to S (-1), which retains a periodic variation superimposed upon an over-all increase with increasing atomic number Z. For μ greater than or equal to 0, the Z dependence of the moments becomes dominated by inner-shell contributions; as μ increases, the over-all increase with Z becomes more rapid. Another perspective of the voluminous data is gained by plotting log S (μ) vs μ. The plot reveals three classes of behavior: "tight," "intermediate," and "loose" atoms. Comparisons with experiment and more detailed calculations are made where possible.

4113 Broadening and shift of the sodium diffuse series by noble gas. Kielkopf, J.F.; Knollenberg, R.B. (Argonne National Lab., IL). *Phys. Rev., A*; **12**: No. 2, 559-566(Aug 1975).

The impact broadening due to He, Ne, Ar, Kr, and Xe of the Na 3p ^{2}P/sub 1/2/ - 4d ^{2}D/sub 3/2/ (5683 A) line was measured at a temperature of 500°K. In addition, impact shifts of this line and other diffuse series lines up to the transitions from 6d ^{2}D

were also determined. The observed broadening and shift rates are in agreement with Lindholm-Foley calculations using semiempirical alkali-metal-noble-gas potentials reported previously. A comparison of calculated and observed shifts show that alkali-metal-helium potentials are somewhat more repulsive than previously thought, and also that the collision-averaged potentials corresponding to 3p ^{2}P/sub 3/2/ are less attractive than those for 3p ^{2}P/sub 1/2/. It is concluded that the use of these potentials in the impact approximation will predict the broadening and shift of alkali-metal spectral lines by noble gases with an accuracy of 10 to 20 percent. (auth)

POSITRONIUM, MUONIUM, AND MUONIC AND MESIC ATOMS AND MOLECULES

4114 (COO—2184-7) **Progress report for Nuclear Chemistry Project. Period covered: October 1, 1974—September 30, 1975.** (Princeton Univ., N.J. (USA). Dept. of Physics). 30 Jun 1975. Contract E(11-1)-2184. 27p. Dep. NTIS $5.00.

Research on investigations of chemical bonding influences on the moderation and capture of negative mu mesons when stopped in matter, nuclear energy levels, internal fields in solids, and the validity of certain semiclassical approximations made in the treatment of nuclear rotational motion. (JFP)

COLLISION PHENOMENA

4115 Two-potential eikonal approximation for electron-atom collisions. Ishihara, T.; Chen, J.C.Y. (Department of Physics and Institute for Pure and Applied Physical Sciences, University of California at San Diego, La Jolla, California 92037). *Phys. Rev., A;* **12**: No. 2, 370-374(Aug 1975).

The Glauber approximation is known to be in appreciable error at all angles when applied to the elastic electron-atom scattering at medium and lower energies. It is shown that this is not due to the frozen-target approximation but mainly a result of the inadequate semiclassical treatment of close-encounter collisions in the Glauber approximation. A simple method is proposed to correct this inadequacy and is applied to e-H elastic scattering at energies from 20 to 100 eV. A remarkable improvement over the Glauber approximation is obtained, and the results agree with experiments very well at all angles where measurements are available.

4116 (UCRL—51893) **Investigation of nonlinear processes associated with the resonant interaction of infrared CO_2 laser radiation with molecular systems.** Kelly, P.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Sep 1975. Contract W-7405-Eng-48. 304p. Dep. NTIS $7.60.

Thesis.

The observation of ultraviolet luminescence emitted by the NH radical resulting from the dissociation of NH_3 as produced by the absorption of high-power, short-pulse CO_2 laser radiation is described and explained by a thermal model for the conditions specified. The observation of Doppler-free two-photon absorption in the ν_3 band of CH_3F and in the ν_2 band of NH_3 using two fixed-frequency cw CO_2 infrared optical fields in combination with molecular Stark tuning is also described. The coincidences of the P14 and P30 lines of two oppositely directed CO_2 lasers at 9.4 μm with the R(1,1)/sub 0 yields ν_3/ and R(2,1)/sub ν_3 yields $2\nu_3$ lines of $^{13}CH_3F$ are used to measure the self-broadening coefficient ($\Delta\nu$/sub p/ = 41.3 +- 1.0 MHz/torr) and pressure shift ($\Delta\nu$/sub s/ = 2.1 +- 0.1 MHz/torr) of the 0 yields $2\nu_3$ transition. Similarly, the coincidences of the P34 and P18 lines of two oppositely directed CO_2 lasers at 10.6 μm with the aQ(5.4)/sub 0 yields ν_3/ and aQ(5,4)/sub ν_2 yields $2\nu_2$ lines of $^{14}NH_3$ are used to measure a self-broadening coefficient ($\Delta\nu$/sub p/ = 28.8 MHz/torr) of the 0 yields $2\nu_2$ transition. Pressure broadening coefficients of $^{13}CH_3F$ and $^{14}NH_3$ with different foreign gas perturbers are also reported. These pressure broadening results are explained by current line broadening theories. Additionally, the vibrational transition dipole matrix elements for the 1^+in equilibrium 2^- and 2^- in equilibrium 2^+ transitions in the ν_2 mode of $^{14}NH_3$ are determined to be 0.27 +- .05 debye and 0.83 +- .08 debye respectively. (auth)

4117 Inelastic electron scattering. *Methods Exp. Phys.;* **3**: 868-952(1974).

The discussion of the scattering of electrons by atoms and molecules includes the similarity of electron impact spectra intensities to those of optical absorption spectra in terms of the Born approximation, deviations from the Born approximation, apparatus for testing the approximate theory, highlights from relative intensity measurements, techniques for absolute intensity measurements, and the definition of a generalized oscillator strength in terms of collision cross sections. (JFP)

4118 Long-lived molecular Rydberg states. Klots, C.E. (Oak Ridge National Lab., TN). *J. Chem. Phys.;* **62**: No. 2, 741-742(15 Jan 1975).

The existence of molecular Rydberg states long lived with respect to dissociation is shown to be common. It is found that there are states in cyclopropane ethane, and possibly ethylacetylene above their respective first ionization limits which are long-lived with respect to radiation, dissociation and autoionization. (1 fig, 11 refs) (GHT)

4119 Dynamics of the reaction of N^+ with H_2. II. Reactive scattering at relative energies below 3 eV. Fair, J.A.; Mahan, B.H. (Univ. of California, Berkeley). *J. Chem. Phys.;* **62**: No. 2, 515-519(15 Jan 1975).

The reaction N^+ (H_2,H) NH^+ has been investigated in the range of initial relative energies from 0.79 to 2.8 eV. Despite the deep potential energy well (6 eV) associated with the symmetric NH_2^+ molecule ion, the reaction proceeds predominately by a direct interaction mechanism at relative energies as low as 2 eV. Only when the initial relative energy is near or below 1 eV does a long-lived complex mechanism appear to predominate. This behavior can be rationalized in terms of the qualitative features of potential energy surfaces deduced for the system from an electronic state correlation diagram. (2 figs, 19 refs) (auth)

ATOMIC AND MOLECULAR THEORY

4120 Shape resonances in K-shell photoionization of diatomic molecules. Dehmer, J.L. (Argonne National Lab., IL); Dill, D. *Phys. Rev. Lett.;* **35**: No. 4, 213-215(28 Jul 1975).

K-shell photoionization spectra of diatomic molecules can exhibit strong shape resonances near threshold. The molecular field is decisive in this phenomenon. It induces the resonant contraction of high-l components of the ionization channels, and it couples these components with low-l components produced in the atomic cores by K-shell photoionization. The effect is demonstrated for N_2 using the multiple-scattering model. Clear evidence for this phenomenon exists for N_2, CO, and NO. (3 figs, 14 refs) (auth)

4121 (LBL—3917) **Coherence in multilevel systems.** Breiland, W.G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 177p. Dep. NTIS $7.75.

Thesis.

Mathematical descriptions of an excited state multilevel system are developed to include progressively the effects of coherent coupling, feeding, decay and relaxation, and the expressions are illustrated with several pulse coherence experiments utilizing zero field optically detected magnetic resonance of excited triplet states. A new method is described in which the time development of the coherent components in a multilevel system is monitored by using an observable that can measure only relative populations between the levels. The method is illustrated. By treating a coherently driven excited state system as two levels in contact with a population reservoir, exact expressions are obtained for both transient and steady-state behavior in the presence of transverse and spin lattice relaxation, constant incoherent pumping, spontaneous emission between the two levels, and also decay back into the reservoir. The general mathematical development is applied specifically to zero field microwave phosphorescence double resonance. Experimental methods and apparatus are discussed in detail and results of optically detected transient mutations, spin echoes, and Fourier transform spectroscopy are presented. (26 figs, 220 refs) (auth)

4122 (UCCND-CSD-INF—58) **Hartree—Fock calculation of various excited states of neutral and ionized iron.** Nestor, C.W. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). Oct 1975. Contract W-7405-eng-26. 13p. Dep. NTIS $4.00.

The Hartree—Fock computer program of Charlotte Froese Fischer was used to calculate configuration-averaged wave functions, binding energies, and radial expectation values for the ground states and the first few excited states of neutral and ionized iron, through helium-like Fe XXV ($1s^2$). A tabulation of the binding energies, a comparison of calculated and experimental ionization potentials, and a plot of the mean radius (r) vs effective nuclear charge for the outermost electrons in several of the excited states is presented. (auth)

4123 Satellite structure in the x-ray photoelectron spectra of the K shell of transition metal compounds. Carlson, T.A.; Carver, J.C.; Vernon, G.A. (Oak Ridge National Lab., TN). *J. Chem. Phys.;* **62**: No. 3, 932-935(1 Feb 1975).

Satellite structure has been measured in the x-ray photoelectron spectra for $FeCl_3$, $FeBr_3$, $K_3Fe(CN)_6$, and $K_4Fe(CN)_6$. Specifically, comparisons were made of the satellites

found in photoelectron spectra of the 2p and 1s subshells of iron. To interpret the data, calculations are presented on electron shake up and shake off, and multiplet splitting as a function of the location of the inner shell vacancy in iron. It is demonstrated, theoretically, that satellite structure found in the photoionization of the K shell of iron must be due to electron shake up and not multiplet splitting. From experimental data on $FeCl_3$ and $FeBr_3$, the conclusion is reached that the satellite structure formed as the result of photoionization in the 2p shell is due primarily to electron shakeup. (8 figs, 5 tables, 34 refs) (auth)

4124 Critical test of semiempirical FH_2 potential energy surfaces: the barrier height for H + FH yields HF + H. Bender, C.F. (Univ. of California, Livermore); Garrison, B.J.; Schaefer, H.F. III. *J. Chem. Phys.*; **62**: No. 3, 1188-1190(1 Feb 1975).

The H + FH barrier, as obtained from a priori electronic structure theory, is reported. The theoretical method used was similar to but more exhaustive than that adopted in earlier studies of F + H_2, H + F_2, and F + HF. (1 table, 21 refs) (GHT)

4125 Quantum dynamics of vibrational relaxation in condensed media. Diestler, D.J. (Purdue Univ., Lafayette, IN); Wilson, R.S. *J. Chem. Phys.*; **62**: No. 4, 1572-1578(15 Feb 1975).

The Zwanzig-Mori projection-operator formalism is employed to describe the dynamics of relaxation in a prototypic model well known for its application to a variety of physical problems: a harmonic oscillator coupled to a heat bath. First an exact equation of motion in generalized Langevin form is obtained for G(t), the expectation value of the occupation number of the oscillator, known to be in a definite initial nonequilibrium state. This equation is then solved in the appropriate van Hove weak-coupling, long-time limit for the usual case of physical interest in which the oscillator-bath interaction is linear in the oscillator coordinate. In this case G(t) is found to decay exponentially with a time constant tau/sub l/ = tau/sub d//2, where tau/sub d/ is the so called "dephasing" time, i.e., the time constant associated with the exponentially decaying time correlation function of the oscillator coordinate, [Q(0) Q(t)]. The approach taken here, which may be easily generalized, leads in a rather natural and straightforward way not only to relations between different relaxation times but also to useful explicit expressions for these times. (auth)

4126 Low field Zeeman effect and the mechanism of the S_1 yields T_1 nonradiative process. El-Sayed, M.A.; Leyerle, R. (Univ. of California, Los Angeles). *J. Chem. Phys.*; **62**: No. 4, 1579-1580(15 Feb 1975).

The low field Zeeman effect is used to distinguish between direct and indirect mechanisms of nonradiative intersystem crossing in the case when two triplet states are located below the lowest singlet state. (GHT)

4127 LMO description of multiple bonding and multiple lone pairs. England, W. (Ames Lab., IA). *J. Chem. Educ.*; **52**: 427-428(Jul 1975).

There is an inherent flexibility associated with any single determinant closed-shell molecular orbital wave function, namely, each such wave function is unchanged by a unitary transformation of the occupied molecular orbitals. Consequently, there are infinitely many sets of molecular orbitals associated with each closed-shell system, and for example, observables can be calculated with sets of localized or delocalized molecular orbitals. Energy localized molecular orbitals are a particular set of closed-shell molecular orbitals. They are defined by mathematical criteria which are reviewed. The physical significance of these criteria are given. (GHT)

4128 Effect of temperature on the oscillator strength of a nonrigid molecule. Kordas, J.; Avouris, P.; Ashraf El-Bayoumi, M. (Michigan State Univ., East Lansing). *J. Phys. Chem.*; **79**: No. 22, 2420-2423(23 Oct 1975).

Experimental results are presented showing the increase of oscillator strength of an electric dipole allowed transition upon cooling in the case of a flexible molecule, tetraphenylmethylbutadiene (TPMB). These results are interpreted in terms of thermal excitation of low-frequency distortion modes and a geometry-dependent transition moment. The difference in temperature dependence of the absorption intensity in hydrocarbon and alcoholic solvents gives some evidence of what appears as a genuine viscosity effect on the absorption intensity. (auth)

FLUID PHYSICS

GENERAL FLUID DYNAMICS

4129 (LA-UR—75-1939) **Methods for calculating multidimensional, transient free surface flows past bodies.** Nichols, B.D.; Hirt, C.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 26p. (CONF-751059—1). Dep. NTIS $4.50.

From 1. international conference on numerical ship hydrodynamics; Gaithersburg, Maryland, USA (20 Oct 1975).

Numerical methods for calculating multidimensional, transient, free surface flows interacting with general curved boundaries are discussed. To model a free surface effectively, three problems must be resolved compatibly: the surface must be numerically defined, a prescription must be provided to advance it in time, and appropriate boundary conditions must be applied at the location of the surface. Basic motions of Lagrangian and Eulerian finite difference representations are reviewed first. All the free surface schemes discussed are couched in one basic solution algorithm, a direct extension of the Marker-and-Cell method. A detailed description, including advantages and disadvantages, is given of free surface computational schemes that make use of the surface height function, surface marker particles, and the volume fraction and variable density schemes. An illustration is given of the added mass and damping coefficients computed for rectangular cylinders undergoing forced oscillation. (8 figures) (RWR)

4130 (ORO—3443-55) **Homogenization and its application. Mathematical and computational problems.** Babuska, I. (Maryland Univ., College Park (USA). Inst. for Fluid Dynamics and Applied Mathematics). Jul 1975. Contract AT(40-1)-3443. 27p. Dep. NTIS $4.50.

Homogenization is an approach which studies the macrobehavior of a medium by its microproperties. The approach is applied to the diffusion problem in a periodic heterogeneous medium and to the analysis of composite materials. The problem is studied for stationary and nonstationary cases, and in infinite and bounded domains. (4 figures, 2 tables) (RWR)

PROPERTIES AND STRUCTURE OF FLUIDS

4131 Pool boiling heat transfer to liquid helium and liquid nitrogen in a nearly zero gravity environment. Edeskuty, F.J.; Williamson, K.D.; Taylor, J.F. (Los Alamos Scientific Lab., NM). pp 258-261 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

A rocket-borne experiment was designed to obtain steady data on nucleate boiling heat transfer to liquid helium and liquid nitrogen in a nearly zero gravity environment. The experiment was successfully launched and was maintained at nearly zero gravity for five and one-half minutes. Under this condition the peak nucleate heat flux was reduced below the 1 g value. The results obtained are presented. (3 figures, 1 table) (auth)

4132 Global phase diagram for a spin-3/2 Ising model of ternary fluid mixtures. Krinsky, S.; Mukamel, D. (Brookhaven National Lab., Upton, NY). *Phys. Rev., B*; **12**: No. 1, 211-215(1 Jul 1975).

Recently, a lattice-gas model of a ternary fluid mixture was introduced which located a nonsymmetric tricritical point within the mean-field approximation. Here, the global phase diagram is presented in the four-dimensional space composed of temperature (T) and the chemical potentials (μ_1, μ_2, μ_3) corresponding to the three types of constituent molecules. It is believed that many features of the model phase diagram have quite general validity, and experimental testing of the predictions is suggested. Results are consistent with Gibbs phase rule, but they go beyond it, by predicting the number of critical and coexistence surfaces of a given order, and their connectivity properties. (5 tables, 9 figures) (auth)

MAGNETOHYDRODYNAMICS

4133 Numerical solution of Landquist equations of magnetohydrodynamics. Johnston, R.L.; Pal, S.K. *Math. Comput.*; **28**: No. 125, 33-44(Jan 1974).

A method of solution for a hyperbolic system of partial differential equations is presented. The solution is obtained by numerically integrating along a selected bicharacteristic, and the difference in solution obtained by using a different bicharacteristic is on the order of the truncation error. The requirements for stability are presented. The method is used to treat two sample problems of wave propagation in an inviscid electrical conducting adiabatic fluid in the presence of electric and magnetic fields. One solution is for the three-dimensional propagation of small pressure disturbance in a compressible fluid, and the other is for cylindrical

waves which simulate the sudden release of a compressed mass of conducting gas in the presence of a magnetic field, i.e., a stellar explosion. In each case, the exact solution and numerical solution of the linear equation, and the numerical solution of the nonlinear equations are presented. The paper is clearly written, is adequately referenced, and should be of interest to those attempting solutions of multidimensional nonlinear hyperbolic systems of partial differential equations. (Appl. Mech. Rev.)

SUPERFLUIDITY

4134 **Superfluid density of ^{3}He measured by fourth sound.** Kojima, H.; Paulson, D.N.; Wheatley, J.C. (Univ., of California, San Diego, La Jolla). Contract AT(04-3)-34. *J. Low Temp. Phys.*; **21**: No. 3/4, 283-305(Nov 1975).

Superfluid density of ^{3}He has been measured using fourth sound in two superleaks: "confined," packed powder and "open," parallel channels. The superleak pore size has little effect on the superfluid density near the melting pressure, but it has surprisingly large effects at lower pressures. The open, parallel channel superleak results show an unexpected pressure dependence of "strong coupling" effects and an unexpectedly small superfluid density change at the B yields A transition. (10 figures) (auth)

4135 **Very low temperature properties of liquid helium-3.** Goldstein, L. (Los alamos Scientific Lab., NM). *J. Low Temp. Phys.*; **21**: No. 3/4, 321-345(Nov 1975).

Heat capacity and phase-boundary-line data on liquid ^{3}He in the few millikelvin temperature range obtained by Wheatley and his co-workers are analyzed within the framework of thermodynamics. The data favor the thermally anomalous disordered high temperature liquid phase to become of normal thermal behavior in its ordered B phase. The latter exhibits entropy decrease on isothermal compression, or its isobaric volume expansion coefficient is positive. At temperatures substantially below the phase-boundary temperatures, the ordered liquid might revert smoothly into a modification of anomalous thermal behavior, i.e., with entropy increase on isothermal compression. This alternation in the thermal behavior of the B phase, on experimental confirmation, could become helpful for a determination of the nature of its dominant thermal excitations in the indicated two temperature ranges, a situation reminiscent of the one existing in liquid ^{4}He II. Currently available magnetic susceptibility data raise the possibility, at very low temperatures, of further cooling liquid ^{3}He-B on adiabatic magnetization. (2 tables, 4 figures) (auth)

PARTICLE INTERACTIONS AND PROPERTIES - EXPERIMENTAL

ELECTROMAGNETIC INTERACTIONS

4136 (COO—2232A-26) **Direct electrons at the CERN ISR. I. A study of the s-dependence and of correlated charged particles.** Buesser, F.W.; Camilleri, L.; Di Lella, L. (Rockefeller Univ., New York (USA)). 1975. 18p. (CONF-750855—8). Dep. NTIS $4.50.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

A previously reported observation of electrons produced in proton-proton collisions at the CERN ISR was extended to 5 different center-of-mass energies ($\sqrt{s}$ = 23.5, 30.6, 44.8, 52.7 and 62.4 GeV). The apparatus detected electrons with transverse momenta, p*/sub T/, greater than 1.0 GeV/c. The ratio of the electron to pion cross sections in the kinematic region is approximately 10^{-4}. The momentum spectrum and particle composition of particles emitted with Δphi approximately 180^0 relative to the electrons are found to be similar to those emitted with pions. Results at p*/sub T/ less than 1 GeV/c are presented in another work. (auth)

4137 (COO—2232A-28) **Observation of J(3.1) production in proton—proton collisions at the CERN ISR.** Buesser, F.W.; Camilleri, L.; Di Lella, L. (Rockefeller Univ., New York (USA)). 1975. 15p. (CONF-750855—10). Dep. NTIS $4.50.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

In an experiment performed at the CERN Intersecting Storage Rings (ISR), 11 e^+e^- pairs of high invariant mass value (greater than 2.5 GeV/c^2) were observed. Of these events, 9 can be interpreted as arising from the reaction p + p yields J(3.1) + anything. The cross section for this reaction is estimated and compared with the result obtained at lower center-of-mass energies. (auth)

4138 (LBL—4281) **Quantum electrodynamics with the spear magnetic detector.** Zipse, J.E. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 163p. Dep. NTIS $7.75.

Thesis.

One makes a study of quantum electrodynamic processes which are present at the SPEAR colliding beam magnetic detector. We begin by describing the experiment performed by the SLAC-LBL collaboration and the results concerning the strong interaction. Then the interactions e^+e^- yields e^+e^- and e^+e^- yields $\mu^+\mu^-$ are considered along with their third-order radiative corrections. These events, previously used to determine new limits for cutoff parameters in QED breakdown models, are further studied to show that the full distribution in coplanarity angle fits the theoretical prediction well. The major focus is on the fourth order two-photon process, e^+e^- yields $e^+e^-A^+A^-$, which only recently has been realized to be significant in such experiments. Cross sections are derived and calculated exactly for this process and the results compared to a Weizacker-Williams equivalent photon calculation. The two-photon data are then isolated and fit to the calculation. A special experiment was done where the small-angle scattered electron or positron is "tagged" along with particles in the main detector. Cross sections and coplanarity distributions are measured and compared to calculation. Through these studies, one feels confident that one understand the nature of the two-photon process in the detector. One further explores the hadronic physics of the two-photon process, e^+e^- yields e^+e^- hadrons, measuring pion cross sections, searching for resonances, and discussing future experiments. (auth)

WEAK INTERACTIONS

4139 (COO—1428-428) **Inclusive look at nup and nup charged-current reactions below 6 GeV.** Barish, S.J.; Derrick, M.; Dombeck, T. (Argonne National Lab., Ill. (USA); Purdue Univ., Lafayette, Ind. (USA)). 1975. 29p. (CONF-750855—4). Dep. NTIS $5.00.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

Preliminary results are presented from a study of inclusive charged-current neutrino interactions from threshold to 6 GeV on a pure proton or deuteron target by summing exclusive reactions at energies up to 6 GeV. Both νn and νp total cross sections are found to rise with energy, and the neutron-to-proton cross section ratio is measured to be 1.40 +- 0.31 for E/sub nu/ greater than 2 GeV. The Y and X distributions and the cross sections for quasi-elastic scattering, excitation functions, single π, 2π, and 3π production are discussed. It is found that the precocious scaling observed previously holds equally for the individual ν—proton and ν—neutron interactions. (JFP)

STRONG BARYON-INDUCED INTERACTIONS

4140 (CONF-750858—6) **Measurements of total cross sections between 23 and 280 GeV/c.** Koehler, P.F.M. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). 1975. 4p. Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

The high precision measurements of the total cross sections for π/sup +-/, K/sup +-/, p, and anti p scattering from H_2 and D_2 were continued with an extension of the energy range from 23 to 280 GeV/c. (JFP)

4141 (COO—2232A-27) **High transverse momentum phenomena involving π and eta mesons.** Buesser, F.W.; Camilleri, L.; Di Lella, L. (Rockefeller Univ., New York (USA)). 1975. 32p. (CONF-750855—9). Dep. NTIS $5.00.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

The inclusive production of π and eta mesons at theta/sub cm/ = 90^0 was measured for proton-proton collisions at five center-of-mass energies between 23.5 and 62.4 GeV. The momentum correlation of charged particles emitted together with a large transverse momentum π was also studied using two magnetic spectrometers each centered at theta/sub cm/ = 90^0. (auth)

4142 **Observation of a high-mass Δ^{++} produced in association with K*, rho and ω.** Chung, S.U.; Protopopescu, S.D. (Brookhaven National Lab., Upton, N.Y. (USA)); Eisner, R.L. (Case Western Reserve Univ., Cleveland, Ohio (USA)); Alston-Garnjost, M.; Barbaro-Galtieri, A.; Friedman, J.H.; Lynch, G.R.; Rabin, M.S.; Solmitz, F.T. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.); Flatte, S.M. (California Univ., Santa Cruz (USA)). *Phys. Lett., B;* **57**: No. 4, 384-388(21 Jul 1975).

Strong evidence is presented for quasi-two-body production of a π^+p enhancement with mass 1881 +- 6 MeV and width 219 +- 23 MeV, recoiling off vector mesons rho^0 and ω from π^+p interactions at 7.1 GeV/c and K*^{0}(890) from K$^+$p interactions at 12 GeV/c. The most probable J/sup P/ assignment for this object is 7/2$^+$, making it a likely candidate for the Regge recurrence of Δ(1236). (auth)

STRONG MESON-INDUCED INTERACTIONS

4143 (CONF-750858—3) **Search for charm in 250 GeV/c π^-p interactions.** Bogert, D.; Hanft, R.; Albright, J.R. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Oct 1975. 12p. Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

A study was made of the reaction π^- + p at 250 GeV/c in order to search for charmed particles. Cross sections, effective mass distributions, and an upper limit for each decay mode were found. However, no evidence was found for charmed particles. (JFP)

4144 (COO—1428-425) **Energy dependence of PI$^-$ elastic scattering at cos THETA/sub CM/approx. -.96.** Dixon, R.L.; Fletcher, J.M.; Garfinkel, A.F.; Loeffler, F.J.; Madrak, S.; Shibata, E.I.; Stanfield, K.C.; Tang, Y.W.; Hoffman, E.W. (Purdue Univ., Lafayette, Ind. (USA); Argonne National Lab., Ill. (USA)). 1975. 3p. (CONF-750858—8). Dep. NTIS $4.50.

From Meeting of the ASP division of particles and fields; Seattle, Washington, USA (27 Aug 1975).

The differential cross section was measured for π^-p yields pπ^- near the backward direction for incident laboratory momenta between 3.0 and 5.5 GeV/c. Preliminary results are reported at cos theta* approximately -0.96. Evidence is seen for Δ(2850) and Δ(3230); however, no evidence was found for the narrow resonance at P/sub lab/ approximately 5.12 GeV/c reported by Kormanyos et al. (auth)

4145 (COO—1545-170) **High statistics study of omega^0 production at 6 GeV/c.** Shaevitz, M.H. (Oklahoma State Univ., Stillwater (USA)). 1975. 166p. Dep. NTIS $7.75.

Thesis.

The spin-projected cross sections for ω^0 production at 6 GeV/c were measured in a counter-spark chamber experiment at the Zero Gradient Synchrotron of Argonne National Laboratory. Results are presented for a sample of 25,000 ω^0 events, and critical tests are shown for any residual background. The reaction is dominated by the s-channel natural-parity helicity one projection (rho$_{11}$ + rho/sub 1-1) dsigma/dt which shows a turnover in the forward direction and no strong dip at t = 0.6 (GeV/c)^2. The unnatural-parity helicity-zero cross section rho$_{00}$ dsigma/dt shows no forward turnover suggesting a sizeable helicity-nonflip contribution. Comparisons are made with the predictions of a Regge exchange model with absorptive corrections. (auth)

PARTICLE INTERACTIONS AND PROPERTIES - THEORETICAL

GENERAL

4146 (FERMILAB—75/70-THY) **Heavy quarks and their experimental consequences.** Appelquist, T. (Fermi National Accelerator Lab., Batavia, Ill. (USA)). Sep 1975. 22p. (CONF-750729—3). Dep. NTIS $4.50.

From New directions in hadron spectroscopy meeting; Argonne, Illinois, USA (7 Jul 1975).

Recent theoretical work on heavy quark dynamics is reviewed. In the context of a color gauge theory of strong interactions, the structure of heavy quark-antiquark bound states and their decay properties is discussed. The emphasis is on the dynamical differences between heavy and light quark bound states. It is suggested that the former will more directly reflect the structure of the underlying field theory. (auth)

4147 **Rudiments of light-cone physics.** Jaffe, R.L. (Stanford Univ., CA). pp 301-322 of In Highlights in particle physics. Vol. 10. Zichichi, A. (ed.). Bologna; Editrice Compositori (1973).

From International school of subnuclear physics; Sicily, Italy (7 Jul 1972).

See CONF-720750—.

An elementary exposition of the concepts and mathematical techniques of light cone physics is given including light-cone dominance, light-cone expansions and the measurement of light-cone singularities, free field light-cone singularities, and the proton model without partons. (JFP)

4148 **Rapidity gap distributions and clustering in multiparticle production.** Krzywicki, A.; Quigg, C. (Fermi National Accelerator Lab., Batavia, Ill. (USA)); Thomas, G.H. (Argonne National Lab., Ill. (USA)). *Phys. Lett., B;* **57**: No. 4, 369-372(21 Jul 1975).

A general formula is obtained for the rapidity gap distribution in short-range order models and the exponential slope at large gaps is related to the behavior of topological cross sections. (auth)

ELECTROMAGNETIC INTERACTIONS

4149 (LBL—4260) **Analysis of a reported magnetic monopole.** Alvarez, L.W. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 16 Sep 1975. Contract W-7405-ENG-48. 24p. (CONF-750855—3). Dep. NTIS $4.50.

From International symposium on lepton and photon interactions at high energies; Stanford, California, USA (21 Aug 1975).

It is shown that there are several substantive errors in a previous work on a cosmic ray event which is consistent with the hypothesis that it was caused by a magnetic monopole. It is shown that the data points fit to the hypothesis that the responsible particle is a platinum nucleus fragmenting to osmium and then to tantalum. (JFP)

4150 (SLAC-PUB—1650) **Theory of electron—positron annihilation into hadrons.** Gilman, F.J. (Stanford Linear Accelerator Center, Calif. (USA)). 1975. 24p. (CONF-750853—5). Dep. NTIS $4.50.

From Symposium on lepton and photon interactions; Stanford, California, USA (21 Aug 1975).

The total cross section for e$^+$e$^-$ yields hadrons and R, its ratio to the muon pair cross section, the physics below and above the threshold near 4 GeV cms with particular attention to what is changing there and exactly where it happens, and inclusive distributions and jets of final state hadrons are treated. (auth)

4151 **Application of the string model of hadrons to the inelastic scattering of electrons.** Tassie, L.J. (Australian National Univ., Canberra). *Aust. J. Phys.;* **28**: No. 1, 15-20(Feb 1975).

A simple string model of hadrons, which is in agreement with scaling, is applied to the deep inelastic scattering of electrons by the nucleon and is used to make predictions of the average charge and the types of particles produced. In particular, the total baryon number of the particles produced in the photon fragmentation region is shown to be 0 for x approximately equal to 0 and 1 for x approximately equal to 1, where x is the Bjorken scaling variable. (auth)

4152 **Electromagnetic interaction of neutrinos in gauge theories of weak interactions.** Cung, V.K.; Yoshimura, M. (Univ. of Pennsylvania, Philadelphia). *Nuovo Cim., A;* **29A**: No. 4, 557-564(21 Oct 1975).

The scattering of neutrinos off real or virtual photons is examined in the gauge theories of weak interactions. Finite amplitudes of order Gα are calculated in the fourth-order perturbation for various models. (auth)

WEAK INTERACTIONS

4153 (LBL—4275) **Determination of the K/sub L/^{0} yields $\pi^-\mu^+\nu$/sub μ/ form factor $\xi(q^2)$ by muon polarization measurements.** Shen, G. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-eng-48. 115p. Dep. NTIS $6.50.

Thesis.

The polarization of the muon in the decay K^0/sub L/ yields $\pi^-\mu^+\nu$/sub μ/ was measured as a function of q^2, the four-momentum transferred to the lepton pair. The kinematic information was used to compute the polarization expected on the basis of various assumed values of the form factor xi(q^2). By comparing the interpolated curve of the polarization as a function of xi(q^2) to the experimentally measured polarization, one has determined xi(q^2) as a function of q^2. If one parameterizes the q^2 dependence of xi by xi(q^2) = xi(0) + Λ q^2/m^2/sub π/, then xi(0) = 0.178 +- 0.105 - 3.80 Λ. (auth)

STRONG INTERACTIONS, BARYON NO. 0

4154 **Monte Carlo generation of two body resonant states.** Knop, R.E. (Florida State Univ., Tallahassee). Contract AT(40-1)-2509. *J. Comput. Phys.;* **18**: No. 2, 115-118(Jun 1975).

For Monte Carlo calculations of elementary particle processes, the transition rate integral can be written in terms of intermediate mass variables. Events generated in this way bear a weight factor consisting of the product of the squared transition amplitude and several two-body phase space factors. Importance sampling, using a Breit—Wigner density, can improve efficiency in

the case that one or more mass variables of the transition density are well approximated by a Breit—Wigner resonance. With the further restriction that the resonance occurs close to threshold and decays to two final-state particles, the efficiency was improved by sampling a probability density which is the product of a Breit—Wigner density times the associated two-body phase space factor. (auth)

STRONG INTERACTIONS, BARYON NO. 1

4155 (LBL—4222) **πN yields πN and KN yields KN low energy data and partial wave analyses recent results and new directions.** Kelly, R.L. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Jul 1975. Contract W-7405-ENG-48. 15p. (CONF-750729—4). Dep. NTIS $4.00.

From New directions in hadron spectroscopy meeting; Argonne, Illinois, USA (7 Jul 1975).

This review deals with πN yields πN and KN yields KN physics below about 3 GeV/c. An attempt is made to convey the state of the art, and to point out what appear to be promising directions for future research. The situation as of about one year ago is summarized in the 1974 Review of Particle Properties and in London conference talks so more recent developments are considered. A comprehensive survey of πN yields πN data between the Δ region and 3 GeV/c is given. Problems associated with spin-rotation experiments are discussed, and the current πN yields πN partial wave analyses. I = 1 and I = 0 KN yields KN analyses, respectively, are considered. (auth)

STRONG INTERACTIONS, BARYON NO. GREATER THAN 1

4156 **Comment on the shapes of multiplicity distributions in pp collisions.** Ferbel, T. (Univ. of Rochester, NY). *Acta Phys. Pol., Ser. B;* **B6**: No. 5, 703-705(1975).

The shapes of multiplicity spectra observed in inelastic pp collisions at high energies are discussed. It is found that a recent observation, which claims that the negative-particle multiplicity is consistent with a Poisson distribution for high multiplicities, is not valid at the highest Fermilab energies. (auth)

PARTICLE INVARIANCE PRINCIPLES AND SYMMETRIES

APPLICATIONS TO ELECTROMAGNETIC AND WEAK INTERACTIONS

4157 **Problems with the Achiman model in the deep-inelastic region.** Razmi, M.S.K. (Institute of Theoretical Science, University of Oregon, Eugene, Oregon 97403). *Phys. Rev., D;* **12**: No. 1, 305-308(1 Jul 1975).

It is pointed out that the prediction of a large charge-symmetry violation by the Achiman gauge-symmetry model also leads to a violation of the positivity condition on the structure function F_3/sup nu//subN. A search for the origins of this inconsistency is made.

FIELD THEORY

4158 (DESY—75/24) **Renormalization problem in a class of nonrenormalizable theories.** Symanzik, K. (Deutsches Elektronen-Synchrotron (DESY), Hamburg (F.R. Germany)). Aug 1975. 34p. (CONF-750693—1). Dep. NTIS (US Sales Only) $4.75.

From 6. GIFT seminar in theoretical physics; Jaca, Huesca, Spain (2 Jun 1975).

A possible way to approach a certain class of nonrenormalizable theories is described. The simplest theory of this class with a probability of existence is chosen, the massless phi^4 theory in more than four space-time dimensions. The problem of extension to other nonrenormalizable theories in the class considered, and the conclusons reached thus far are compared with the corresponding ones for renormalizable theories. (JFP)

4159 **Causal independence in algebraic quantum field theory.** DeFacio, B. (Ames Lab., IA). *Found. Phys.;* **5**: No. 2, 229-237(Jun 1975).

Ekstein has shown that causal independence neither implies nor is implied by commutativity in an infinite-dimensional, reducible construction. DeFacio and Taylor have presented a finite-dimensional irreducible example of Ekstein's proposition. Avishai and Ekstein have shown that the original question regarding locality for algebraic quantum field theories remains open. One concurs with that claim and offers additional arguments. A new demumerably infinite-dimensional, irreducible example is presented which shows that a sort of "orthogonality" among operators is involved. Some observations on local C*- and W*-algebras are given. (auth)

NEUTRON INTERACTIONS WITH MATTER

4160 (BNL—19545) **Small-angle neutron scattering from cobalt in the critical region.** Glinka, C.J.; Minkiewicz, V.J.; Passell, L. (Maryland Univ., College Park (USA); Brookhaven National Lab., Upton, N.Y. (USA)). 1974. 18p. (CONF-741202—19). Dep. NTIS $4.00.

From 20. annual conference on magnetism and magnetic materials; San Francisco, California, USA (3 Dec 1974).

The temperature dependence of the small-angle critical scattering of neutrons from cobalt was measured both above and below its Curie temperature, T/sub c/. From these measurements, both static and dynamic aspects of the critical behavior were studied. Below T/sub c/ the scattering is dominated by well-defined spin wave modes which exhibit nearly quadratic dispersion. As T/sub c/ is approached, the spin waves renormalize and broaden, but no evidence of the longitudinal component of the susceptibility is observed. Above T/sub c/, the exponents $\gamma = 1.23 \pm 0.05$ and $\nu = 0.65 \pm 0.04$ describing the power law dependences of the static susceptibility and the inverse correlation range, respectively, were obtained from the small-angle scans after taking full account of the inelasticity of the scattering. The energy widths of the scattering above T/sub c/ were measured and are well described by a dynamical scaling function over a range of temperature and wave vector extending throughout the critical region and well into the hydrodynamic regime. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19 THEORETICAL

ENERGY LEVELS AND TRANSITIONS

4161 **Particle-hole-rotator coupling model for the giant resonance of ^{12}C.** McDougall, A.; Spicer, B.M. (School of Physics, Melbourne). *Aust. J. Phys.;* **28**: No. 1, 127-131(Feb 1975).

A collective correlations calculation has been made for the giant resonance of ^{12}C. The low-lying states are treated as members of two rotational bands, and higher energy low-lying states are included in the coupling procedure in an attempt to examine the connection of these states with structure in the 30 to 35 MeV region, and to examine a proposed rotational band of states built on the 7.65 MeV (0^+) level. The calculation fails to transfer strength to the extent expected. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=6-19, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

4162 **Measurement of prompt-muon production in nucleon-nucleus collisions.** Bintinger, D.; Curry, J.; Pilcher, J.; Rubbia, C.; Sulak, L.; Ford, W.; Mann, A.K.; Cline, D.; Imlay, R.; Wanderer, P. (The Enrico Fermi Institute, University of Chicago, Chicago, Illinois 60637). *Phys. Rev. Lett.;* **35**: No. 2, 72-75(14 Jul 1975).

We have measured the production cross section for prompt muons relative to pions, produced in nucleon-nucleus interactions at incident energies from 30 to 300 GeV and for muon transverse momenta from 1 to 2.3 GeV/c. Upper limits on the production and leptonic decay of heavy particles are presented.

4163 **Search for narrow resonances produced by neutron dissociation.** Bleser, E.J.; Gobbi, B.; Kenah, L.; Keren, J.; Rosen, J.; Ruchti, R.; Scott, H.; Spelbring, D.; Biel, J.; Bromberg, C.; Ferbel, T.; Slattery, P.; Underwood, D.; Freytag, D. (Fermi National Accelerator Laboratory, Batavia, Illinois 60510). *Phys. Rev. Lett.;* **35**: No. 2, 76-79(14 Jul 1975).

We present the results of a search for charged two-body decays of neutral high-mass resonances produced via neutron dissociation. The spectrometer, located in the M-3 beam at Fermilab, was sensitive to final states produced forward ($x>0.3$) with charged multiplicity approximately-less-than4. We find no significant enhancement in the high-mass K/sup plus-or-minus/πminus-or-plus or pK^- systems. The cross section times branching ratio is approximately-less-than50 nb/nucleon for Kπ masses between 2 and 3 GeV.

NUCLEAR PROPERTIES AND REACTIONS, A=20-38, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

4164 Gamma rays from ^{23}Na states excited in the ^{12}C(^{12}C,p) reaction at E = 38.6 MeV. Cormier, T.M.; Cosman, E.R.; Grodzins, L.; Hansen, O.; Steadman, S.; Van Bibber, K.; Young, G. (Massachusetts Inst. of Tech., Cambridge (USA). Lab. for Nuclear Science). *Nucl. Phys., A;* **247**: No. 2, 377-381(4 Aug 1975).

The ^{12}C(^{12}C,pγ)^{23}Na reaction was studied at a c.m. bombarding energy of 19.3 MeV. At this energy the excitation functions for the proton groups to the 9.04 MeV and 9.81 MeV ^{23}Na states exhibit a strong resonance. The γ-decay of the 9.04 and 9.81 MeV levels was recorded and found to be consistent with the two states being the $^{15}/_{2}^{+}$ and $^{17}/_{2}^{+}$ members, respectively, of the ^{23}Na ground-state rotational band. Other nearby spin values cannot be excluded. (auth)

NUCLEAR REACTIONS AND SCATTERING

4165 (^{3}He,d) reaction on ^{24}Mg and ^{28}Si at 38.5 MeV. Peterson, R.J.; Ristinen, R.A. (Colorado Univ., Boulder (USA). Nuclear Physics Lab.). *Nucl. Phys., A;* **246**: No. 2, 402-412(21 Jul 1975).

The (^{3}He,d) reaction at a sufficiently high energy is considered to be a reliable single-proton stripping direct reaction. The data for the low-lying states produced by this reaction on ^{24}Mg and ^{28}Si are compared to the predictions of the strong-coupling rotational model. The agreement with the model predictions for ^{25}Al is quite good, both for the single-proton spectroscopic factors in that nucleus and most particularly for the excitation of $^{7}/_{2}$+ states in ^{25}Al and ^{29}P by two-step processes. (auth)

4166 Reactions of ^{14}N and ^{16}O ions with p and s—d shell nuclei at E/sub lab/ = 16 to 75 MeV. Holub, R.; Zeller, A.F. (Florida State Univ., Tallahassee (USA). Dept. of Chemistry); Plendl, H.S.; DeMeijer, R.J. (Florida State Univ., Tallahassee (USA). Dept. of Physics). *Nucl. Phys., A;* **246**: No. 2, 515-532(21 Jul 1975).

Yield curves were measured for formation of ^{7}Be and of residual nuclei formed by α-particle and nucleon emission following the reactions of 16- to 75-MeV ^{14}N and ^{16}O ions with thick, natural C, Mg, Al and Si targets. The results are discussed in terms of statistical model calculations. Yield curves calculated with computer codes based on the statistical model are compared with the experimental results. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=39-58, EXPERIMENTAL

ENERGY LEVELS AND TRANSITIONS

4167 Angular correlation measurements in ^{57}Fe. Taylor, R.B.; Hille, F. (Univ. of North Queensland, Townsville, Australia). *Aust. J. Phys.;* **28**: No. 1, 21-24(Feb 1975).

The results of two γ-γ correlation measurements following the thermal capture of neutrons in ^{57}Fe are presented. The spin of the 1.725 MeV state is found to be $3/2^{-}$ and that of the 1.627 MeV state to be $3/2^{-}(5/2^{-})$. The mixing ratios for the decay of the two states have been calculated. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=90-149, EXPERIMENTAL

NUCLEAR REACTIONS AND SCATTERING

4168 (LBL—4081) Continuum gamma rays following (HI, xnγ) reactions. Diamond, R.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-eng-48. 50p. (CONF-750848—1). Dep. NTIS $5.50.

From 8. summer school on nuclear physics; Mikotajki, Poland (24 Aug 1975).

The continuum gamma-ray spectrum following neutron emission in a (HI, xngamma) reaction consists of two parts: a high-energy component whose intensity decreases exponentially with gamma-energy, the initial statistical cascade; and a low-energy bump which usually contains most of the intensity and consists predominantly of stretched E2 transitions, the yrast cascade. The latter cascade carries away most of the angular momentum of the product nucleus, and so there is a good correlation between the average angular momentum of the initial compound nucleus leading to a particular product and the average gamma-ray multiplicity in that reaction. The measured values of the gamma-ray multiplicity show a variation of a factor of ten and have dependencies on the projectile mass and energy which can be explained with simple considerations. Determination of the moment-of-inertia of the nucleus at spins as high as $60\hbar/2\pi$ involves difficulties and is not yet accurate, but is very interesting to do and seems possible of better accuracy. (1 table, 16 figures) (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, THEORETICAL

ENERGY LEVELS AND TRANSITIONS

4169 Shell-model calculations of two to four identical-'particle' systems near ^{208}Pb. McGrory, J.B. (Oak Ridge National Lab., Tenn. (USA)); Kuo, T.T.S. (State Univ. of New York, Stony Brook (USA)). *Nucl. Phys., A;* **247**: No. 2, 283-316(4 Aug 1975).

The structure of the nuclei $^{201-206}$Pb, $^{210-212}$Pb, ^{210}Po, ^{211}At, and ^{212}Rn is studied in terms of conventional nuclear shell models. An inert ^{208}Pb core is assumed, and active particles (holes) are distributed in the low-lying single-particle (hole) orbits. Experimental single-particle energies are used for the one-body part of the effective residual interaction. Realistic interaction matrix elements developed for this mass region by Kuo and Herling are used for the matrix elements of the two-body part of the residual interactions. As much as possible, other effective one-body operators for electromagnetic observables are derived from experimental data on the single-particle (hole) nuclei ^{207}Pg, ^{209}Pb, and ^{209}Bi. Observables treated are ground-state binding energies, excitation energies, strengths for one- and two-particle transfers, and E2 and M1 observables. Generally, excellent agreement is found. The configuration mixing calculations do not remove anomalies in the magnetic moments of excited states in ^{206}Pb and ^{212}Rn. Many states in these nuclei are predicted by the models which have not been observed as yet. It is found that a truncation scheme for doubly even nuclei treated here in which only seniority-0 and seniority-2 states are allowed is potentially very useful. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=190-219, EXPERIMENTAL

MOMENTS AND SPIN

4170 Nuclear orientation of 2.3-d /sup 198m/Au. Mahnke, H.E.; Kaindl, G.; Bacon, F.; Shirley, D.A. (California Univ., Berkeley (USA). Dept. of Chemistry). *Nucl. Phys., A;* **247**: No. 2, 195-202(4 Aug 1975).

The magnetic hyperfine interaction of the T/sub $^{1}/_{2}$/ = 2.3-d high-spin isomeric state of ^{198}Au has been measured in host metals of iron and nickel at temperatures down to 4 mK by using the thermal-equilibrium nuclear orientation technique. The resulting value for the magnetic moment, μ = (+) 5.55 +- 0.35 n.m., strongly supports an interpretation of this state as a [$\pi h^{11}/_{2}$; $\nu i^{13}/_{2}$] 12^{-} configuration analogous to /sup 196m/Au and /sup 200m/Au. The observed γ-ray anisotropies are in agreement with the recently proposed decay scheme of /sup 198m/Au; for the E2/M1 mixing ratio of the 204-keV γ-transition, they result in a value of δ = -0.10 +- 0.05. (auth)

NUCLEAR REACTIONS AND SCATTERING

4171 ^{208}Pb(α,^{3}He)^{209}Pb reaction at 58 MeV. Tickle, R.; Gray, W.S. (Michigan Univ., Ann Arbor (USA). Cyclotron Lab.). *Nucl. Phys., A;* **247**: No. 2, 187-194(4 Aug 1975).

The ^{208}Pb(α,^{3}He)^{209}Pb reaction at 58 MeV has been used to search for high-spin states in ^{209}Pb. Only three levels are excited with appreciable intensity: the ground state ($2g_{9/2}$) and levels at 0.781 ($1i_{11/2}$) and 1.426 MeV ($1j_{15/2}$). The angular distributions for these levels have been measured and analyzed using standard DWBA calculations to obtain spectroscopic strengths. The ^{208}Pb(α, α) elastic scattering was measured, and optical parameters were deduced from the data. A normalization value N = 50 yields spectroscopic values which are close to the values measured in the (d,p) reaction. The (α,^{3}He) reaction should easily pick out any appreciable components of the $j^{15}/_{2}$ shell model state, which weak-coupling calculations predict should be fragmented. However, only three weak transitions previously seen in a (d,p) experiment are observed. (auth)

NUCLEAR PROPERTIES AND REACTIONS, A=220 AND ABOVE, EXPERIMENTAL

4172 **Superheavy elements.** Tsang, C.F. (Univ. of California, Berkeley). *Phys. Teach.*; **13**: No. 5, 279-283(May 1975).

Problems relating to the synthesis and study of superheavy elements are reviewed on an elementary level. Focus is on the predicted "island of stability" around Z = 114. (3 figures) (SDF)

NUCLEAR REACTIONS AND SCATTERING

4173 (DP-MS—75-87) **Status of measured neutron cross sections of transactinium isotopes for thermal reactors.** Benjamin, R.W. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 93p. (CONF-751104—3). Dep. NTIS $7.75.

From IAEA advisory group meeting on transactinium isotope nuclear data; Karlsruhe, F.R. Germany (3 Nov 1975).

Experimentally determined neutron cross sections, resonance parameters, and the average number of neutrons per fission for neutron-induced fission of actinide nuclides in the production chains associated with thermal and near-thermal reactors are summarized and compared with user requests for experimental data. The primary fertile and fissile isotopes ^{232}Th, ^{233}U, ^{235}U, ^{238}U, and ^{239}Pu are excluded from this survey. Integral data, i.e., spectrum-averaged thermal cross sections and resonance integrals, are included, but the emphasis is placed on energy-dependent differential cross sections because of their general utility with any specified neutron energy spectrum. Included with the data summaries are an extensive survey of the literature through August 1975, brief descriptions of measurements known to be in progress or firmly planned for the immediate future, and recommendations for needed measurements. (3 figures, 5 tables) (auth)

NUCLEAR THEORY

NUCLEAR REACTIONS AND SCATTERING

4174 **Statistical emission of large fragments: a general theoretical approach.** Moretto, L.G. (California Univ., Berkeley (USA). Dept. of Chemistry). *Nucl. Phys., A;* **247**: No. 2, 211-230(4 Aug 1975).

A theory for the statistical emission of large fragments is developed. In analogy with the fission saddle point, a ridge line in the potential energy surface is defined which controls the decay width of the system into any two given fragments. The normal modes at the ridge are separated into three classes: decay modes, amplifying modes, and non-amplifying modes. Amplifying modes are those whose thermal fluctuations are amplified and lead to a broadening of the kinetic energy distribution. Analytical expressions for the kinetic energy distributions are developed for various combinations of amplifying and non-amplifying modes. The limit for large amplifications is a Gaussian kinetic energy distribution. The limit for no amplification is a Maxwellian-like distribution. Thus the formalism comprehends the fission decay on one hand and the neutron evaporation on the other. The angular distributions are evaluated in terms of the ridge-line principal moments of inertia. A general analytical expression has been derived which predicts, correctly in both limits, the angular distributions of the evaporated neutrons and of the fission fragments. (auth)

SPONTANEOUS AND INDUCED FISSION

4175 **Note on unitarity in resonance theory.** Bertram, W.K.; Cook, J.L. (Australian Atomic Energy Research Establishment, Sutherland). *Aust. J. Phys.*; **28**: No. 1, 1-5(Feb 1975).

Equations resulting from the unitarity of the collision matrix are investigated in standard resonance theory. The nonuniqueness or otherwise of fitted resonance parameters is discussed. (auth)

RADIATION AND SHIELDING PHYSICS

4176 (COO—623-202) **Mechanical properties of non-metallic thin films.** Hoffman, R.W. (Case Western Reserve Univ., Cleveland, Ohio (USA)). Mar 1975. Contract AT(11-1)-623. 86p. (CONF-7409130—1). Dep. NTIS $7.50.

From Meeting on physics of non-metallic thin films; Corsica, France (1 Sep 1974).

The importance of the mechanical properties, and especially the stress developed as a result of deposition processes and thermal treatment, is demonstrated by significant changes in many properties, in mass transport, and failure. In this review we first define the stress system, including non-uniform stress distributions and interfacial stresses. Different measurement techniques are compared, and the restrictions on the elastic bending equations are developed for the most common geometries. Available data for elements, compounds, and glasses is catalogued and examined for systematic trends. Growth and crazing patterns can also supply qualitative information. The concepts which have been successful in detailing the origin of intrinsic stress in metals are briefly treated. The additional complications arising from the sensitivity to stoichiometry and residual gas or other contaminations are discussed before attempting to develop models for the stress in non-metallic films. Quantitative successes of stress models are few at present. The relevance of the internal stress to failure modes is illustrated by three examples: enhanced mass transport, loss of adhesion, and fracture. (33 figures, 2 tables, 212 references) (auth)

RADIATION PHYSICS

4177 (CONF-751101—29) **Method for processing ENDF/B photon form factor data.** Lucius, J.L.; Greene, N.M. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Computer Sciences Div.). 1975. 4p. Dep. NTIS $4.50.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

A method is described for processing ENDF/B photon data to generate group-to-group scattering matrices. The method has these salient features: 1. It is tailored toward treating the full energy and angular detail with which the cross sections are represented in ENDF/B; 2. It is simple to program; 3. It closely parallels a treatment developed for producing multigroup neutron matrices; 4. The time required to execute the method on a computer varies linearly with the number of energy groups as opposed to double numerical integration schemes which tend to vary as the square of the number of groups. (GHT)

4178 (IEA—38) **Health physics.** Poston, J.W. (Instituto de Energia Atomica, Sao Paulo (Brazil)). Dec 1974. 120p. Dep. NTIS (US Sales Only) $9.00.

Eight lectures prepared for a training course in radiation protection for personnel are included. Topics discussed include: interaction of radiations with matter; radiation quantities and units; the physical basis of radiation dosimetry; the detection and measurement of radiation; dosimetry of mixed radiations; special methods in radiation dosimetry; the dosimetry of electrons and beta rays; and a brief review of radiation biology. (CH)

4179 (SAND—75-0420) **Relativistic E-beam energy deposition in H_2-F_2 mixtures.** McGuire, E.J. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1975. Contract AT(29-1)-789. 66p. Dep. NTIS $5.45.

The production of free fluorine is examined via relativistic electron beam energy deposition in 1:4 mixtures of H_2 and F_2, at atmospheric pressures, on nanosecond timescales. It is found that each free fluorine costs about 9 eV. Key elements in the model are (1) a high H_2 pressure is necessary to slow down fast secondary electrons to the 0-2 eV range on a nanosecond time scale, (2) the initial F atom production mechanism is $e + F_2$ yields F_2^- yields $F + F^-$, while (3) the bulk of the F atom production is via $F^- + F_2^+$ yields 3F. The largest uncertainties in the model are the width of the $e + F_2$ yields F_2^- resonance reaction, and the magnitude of the mutual neutralization cross-section. (18 figures, 26 references) (auth)

4180 **Magnetic scattering of neutrons.** Stassis, C.; Deckman, H.W. (Ames Lab., Iowa). *Phys. Rev., B;* **5**: No. 5, 1885-1898(1 Sep 1975).

The magnetic scattering of neutrons by an arbitrary system of particles was examined by exploiting its similarity to the radiation problem in spectroscopy. It is shown that the magnetic scattering amplitude can be expressed in terms of the multipole moments of the scattering system. The number of multipoles, which contribute to the scattering amplitude, is limited by selection rules based on the symmetry properties of the states of the system, in particular, parity and angular momentum conservaation. The formalism was applied to the magnetic scattering of neutrons by an atom in the l/sup n/ electronic configuration. If the spin--other-orbit and orbit--orbit interactions in the atomic Hamiltonian can be neglected, only even-order electric and odd-order magnetic multipoles, whose order of multipolarity is less than or equal to 2l + 1, contribute to the scattering amplitude. In this case the calculation of the magnetic scattering amplitude is reduced to evaluating matrix elements of the Racah double tensors W/sup (0,k)/ and W/sup (l,k')/ (k' even). The former tensors are associated with the convection current and the latter with the spin magnetization contribution to the magnetic scattering amplitude. The calculation of the matrix elements of these tensors is simplified by selection rules

based on the groups Sp(4l + 2), R(2l + 1), R(3), G_2 used in the classification of the atomic states. The contributions to the magnetic scattering amplitude of the convection current, associated with the spin–orbit and mass correction terms of the atomic Hamiltonian, was examined in some detail. (auth)

SHIELDING CALCULATIONS AND EXPERIMENTS

4181 (CONF-751041—1) **Available computer codes and data for radiation transport analysis.** Trubey, D.K.; Maskewitz, B.F.; Roussin, R.W. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.00.

From Symposium on vulnerability and survivability of surface and aerial targets; San Diego, California, USA (21 Oct 1975).

The Radiation Shielding Information Center (RSIC), sponsored and supported by the Energy Research and Development Administration (ERDA) and the Defense Nuclear Agency (DNA), is a technical institute serving the radiation transport and shielding community. It acquires, selects, stores, retrieves, evaluates, analyzes, synthesizes, and disseminates information on shielding and ionizing radiation transport. The major activities include: (1) operating a computer-based information system and answering inquiries on radiation analysis, (2) collecting, checking out, packaging, and distributing large computer codes, and evaluated and processed data libraries. The data packages include multigroup coupled neutron-gamma-ray cross sections and kerma coefficients, other nuclear data, and radiation transport benchmark problem results. (auth)

MEDICAL PHYSICS

DOSIMETRY

4182 (LA-UR—75-1490) **Microdosimetry of negative pions.** Amols, H.I.; Dicello, J.F.; Lane, T.F. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 20p. (CONF-750927—1). Dep. NTIS $4.00.

From 5. symposium on microdosimetry; Varbania Pallanza, Italy (22 Sep 1975).

The radiation quality of negative and positive pions of initial momentum 168 MeV/c has been determined at eight different depths in a liquid phantom. The measurements were made with a 2.5 cm diameter spherical proportional counter with Shonka A-150 neutron tissue equivalent plastic walls. The gas pressure in the sensitive volume was chosen to simulate a diameter of 2 μm in unit density material. Dose distributions as a function of lineal energy (y) change slowly in the entrance and plateau regions with a dose mean lineal energy (anti y/sub D/) of 6-8 keV/μm. Less than 3 percent of the dose is delivered in excess of 50 keV/μm in this region. In the Bragg peak region the distributions change rapidly as a function of depth with the dose mean lineal energy increasing to 38 keV/μm at the peak and to 57 keV/μm just beyond the peak. On the basis of these microdosimetric data predictions of RBE and OER have been made with the use of both the theory of dual radiation action and also the delta ray theory of cell survival. The former has been used to predict biological response at low doses and the latter at high doses. A comparison is made between the two theories at intermediate doses. The results of these calculations are not inconsistent with recent biological data. (6 figures, 1 table, 20 references) (auth)

4183 (ORNL-TM—5088) **Effects of tissue inhomogeneities on dose patterns in cylinders irradiated by negative pion beams.** Hamm, R.N.; Wright, H.A.; Turner, J.E. (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 43p. Dep. NTIS $4.00.

Effects of the presence of inhomogeneities in tissue irradiated by negative pion beams are investigated. Soft-tissue targets are considered with embedded regions of bone and cavities of air. The absorbed dose is calculated as a function of position in the targets for parallel and converging beams and for two parallel beams that enter the target from opposite sides. Isodose contours are calculated and displayed in each case. While these studies show expected trends, they indicate that specific calculations are needed for other beam parameters and target geometries. The contributions of neutrons to the dose contours can be seen from several calculations made both with and without neutrons. (auth)

SOLID STATE PHYSICS

4184 (ITP—74-170R) **Transverse relaxation in donor—acceptor systems.** Khomenko, Yu.M. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1975. 11p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The equations of motion for the density matrix elements of a donor—acceptor pair are obtained on a specific model taking into account the transverse relaxation processes. The temperature influence on the effectiveness of the given processes is considered, and the role of the transverse relaxation in kinetics of the donor–acceptor excitation transfer is investigated. (1 figure) (auth)

4185 (ITP—75-8P) **Excitons in two-impurity crystals.** Trofimov, A.S. (AN Ukrainskoj SSR, Kiev. Inst. Teoreticheskoj Fiziki). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The stationary states of linear and cubic molecular crystals with impurities of two different types are considered. Allowance for the impurity interaction results in additional splitting of energy levels. The splitting has the highest value for the same impurities. The introduction of impurities of two types deforms all the states of the exciton band. Expressions for the wave functions of all the stationary states arising in a crystal are obtained. (auth)

4186 (JINR—P4-8923) **Theory of acoustic spin resonance by conduction electrons. II. Macroscopic equations.** Vlakhov, I.P.; Kalashnikov, V.P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The temperature balance equations are derived for the kinetic and spin conduction electron degrees of freedom in the slightly nonlinear regime of acoustic spin resonance (ASR). The stationary solutions of these equations are found and discussed. A possible observation of the Overhauser effect in the saturation of ASR and a detection of ASR by the resonance change of the mobility are considered. (auth)

4187 (JINR—P4-8953) **Correlation functions in the binary system theory. II. Systems of ordered type.** Sumkova, O.O.; Fedyanin, V.K. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1975. 16p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An approach to the Ising model based on the series of equations for correlation functions is extended to systems with a phase transition of order—disorder type. (auth)

4188 (JINR—R-4-8032) **Low temperature magnetization for Heisenberg ferromagnet.** Pladkida, N.M.; Rusek, P.R. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1974. 6p. (In Russian). INIS.

5 refs.; submitted to Physics Letters.

Calculated values for the low-temperature magnetization of ferromagnets calculated with the Heisenberg model, spin of 1/2, agreed with Dyson's results. A precise representation for the Green function was demonstrated which leads to a correct low temperature resolution for magnetization that does not contain the nonphysical member T^3. (tr-auth)

4189 (KFKI—75-33) **Possibility of anomalous alignment in nematic liquid crystals without material flow.** Pataki, G. (Kozponti Fizikai Kutato Intezet, Budapest (Hungary)). May 1975. 20p. Dep. NTIS (US Sales Only) $4.00.

A model is presented which gives rise to anomalous alignment in nematic liquid crystals of negative dielectric anisotropy without material flow. The ordering is connected with a static space charge wave perpendicular to the walls of the cell (z axis). The z component of the forces-balance equation allows a reorientation at a threshold voltage U_{10} if no magnetic field is present, and leads to a threshold electric field if H/sub x/ is not equal to 0. The threshold voltage U_{10} has generally a lower value than those of the electrohydrodynamic instabilites. The anomalous alignment has a cut-off frequency, above which no reorientation takes place. The various experimental observations concerning the anomalous alignment support the proposed model. A possible application of the present theory to contact effects is briefly discussed. (2 figures) (auth)

4190 **Crystal-field effects on the apparent spin—orbit splitting of core and valence levels observed by x-ray photoemission.** Ley, L.; Kowalczyk, S.P.; McFeely, F.R.; Shirley, D.A. (Univ. of California, Berkeley). *Phys. Rev., B;* **10**: No. 12, 4881-4888(15 Dec 1974).

Several anomalous relativistic effects in x-ray-photoemission spectra of metals and binary compounds are reviewed and explained in terms of combined spin-orbit and crystal-field interactions. The apparent spin-orbit splitting does not appear to be enhanced by renormalization effects, which would affect the expectation value of xi vector l. vector s itself. The variation of xi vector l. vector s with charge state is not large enough to be important in solids. Rather for both outer p and d shells, the splitting appears to be affected by "crystal-field" terms that carry the lattice symmetry. In III-V and II-VI compounds only the tellurium 4d shell may have a spin-orbit splitting different from that expected

from free-atom data. However, the enhancement is small (3 percent) and consistent with a tetrahedral crystal field. The enhancement of d-shell spin-orbit splitting in Zn and Cd arises from the Y_2 terms in the crystal field because of the large c/a ratio in these lattices. There is no enhancement for Cd in a cubic lattice, while the enhancement in several lattices follows the quadrupole coupling constant of ^{111}Cd, which presumably also arises from Y_2-symmetry terms. The d-band density of xi l.states in fcc Au and Ag is consistent with expectations based on a xi vector l. vector s and Y_4 interaction, but band-structure effects so complicate these cases as to preclude such a simple interpretation. The absence of enhanced splitting in valence-shell p shells in Pb and Bi is explained in terms of the higher symmetry of the p wave functions as compared to that of the d electrons and the partial filling of p-derived valence bands in these metals. (4 figures, 3 tables) (auth)

4191 Model for shock waves in solids and evidence for a thermal catastrophe. Parskin, A. (Queens Coll. of the City Univ. of New York, Flushing); Dienes, G.J. *Solid State Commun.;* **17**: No. 2, 197-200(1975).

Shock-wave experiments and computer simulations yield a linear relation between shock velocity and particle velocity. It is shown that a Mie--Grueneisen equation of state combined with the Hugoniot relations matches the computer results and the experiments and leads to an explanation of the generality of the linear velocity dependence. At high shock velocities the onset of a thermal catastrophe, which results in a maximum shock compression, is predicted from the model. (2 figures) (auth)

4192 Thermodynamics of an itinerant-electron ferromagnet at very low T/sub c//epsilon/sub F/. Murata, K.K. (Brookhaven National Lab., Upton, NY). *Phys. Rev., B;* **12**: No. 1, 282-296(Jul 1975).

The validity of the classical Murata--Doniach model for the thermodynamic properties of weak itinerant magnets near T/sub c/ is discussed in detail. An explicit perturbation expansion for the nontrivial thermodynamic properties in the model is carried out in terms of two small parameters available for very weak transitions. Furthermore, a microscopic examination of quantum corrections (the ω/sub n not equal to 0 modes) suggests that the classical phenomenological model with temperature-independent Ginsburg--Landau (GL) coefficients is valid as T/sub c/ yields 0 if the fluctuation phase space is simply restricted to the thermal population. Thus, if the excitations are paramagnons with q^3 damping, the fluctuations must be cut off at a momentum q/sub m/ ~ T/sup 1/3/. It is found that the model is necessarily phenomenological in the sense that the quantum corrections enter the GL coefficients without benefit of a small parameter. However, given the coefficients, a small parameter is available for the Murata--Doniach model (T/sub c/ε/sub F) if the phase transition happens to be weak. This difficulty should be present in the similar Moriya--Kawabata approach. The coefficients could presumably be determined by detailed fitting to itinerant magnets with T/sub c/ in the 1-K region. (4 figures, 1 table) (auth)

4193 Solid ^{3}He as a Heisenberg antiferromagnet. Johnson, J.D. (Los Alamos Scientific Lab., NM); Cohen, E.G.D. *Phys. Rev., B;* **12**: No. 1, 297-302(1 Jul 1975).

A detailed analysis with a localized magnetic exchange Hamiltonian has been made of existing thermodynamic data on bcc ^{3}He with the bulk of the analysis performed at the molar volumes v = 23.34, 23.88, 24.0, and 24.25 cm^3/mole for T less than 50 mK. The data can be described at all v equally well by four qualitatively different sets of exchange constants. This is true with the possible exception of one set of specific-heat data for which it is not entirely clear that they can be described by a purely magnetic Hamiltonian alone. Expect on the melting curve at v = 24.25 and possibly for the just-mentioned specific-heat data, one of these four sets is the conventional set, which is supported by exchange calculations. All this points to the possibility of a description of bcc ^{3}He different from the conventional picture. Experiments that could clarify the situation are discussed. (1 table) (auth)

4194 Ultrasonic study of liquid crystals. Miyano, K.; Ketterson, J.B. (Northwestern Univ., Evanston, IL). *Phys. Rev., A;* **12**: No. 2, 615-635(Aug 1975).

The ultrasonic velocity and attenuation in magnetically aligned liquid crystals has been measured. All well-known liquid-crystalline symmetries (nematic, cholesteric, and smectic A, B, and C) were studied. Sound anisotropy measurements in the smectic-B and -C and cholesteric materials are reported here for the first time; the measurements in the smectic-C and cholesteric liquid crystals are still in a preliminary stage. The sound velocity anisotropy was unambiguously attributed to the existence of a repeated structure (broken translational symmetry) in the hydrodynamic (low-frequency) limit by measuring the anisotropy across the nematic-smectic-A transition in N-p-cyanobenzylidene-p-octyloxyaniline (CBOOA); a sudden increase of the anisotropy extrapolated to zero frequency was observed at the transition despite a large dispersion. The smectic-A-smectic-B transition in ethyl-p-[(p-methoxybenzylidene)amino] cinnamate shows a two-dimensional liquid-to-solid transition. A distinct minimum was found at the nematic-smectic-C transition in p-p'heptyloxyazoxybenzene which was not accompanied by an attenuation peak. The velocity anisotropy in a cholesteric mixture of cholesteryl chloride and cholesteryl myristate was tentatively assigned to the dispersion. (auth)

4195 Susceptibility expansion for classical scalar models. Van Dyke, J.P.; Camp, W.J. (Sandia Labs., Albuquerque, NM). *Phys. Rev. Lett.;* **35**: No. 6, 323-326(11 Aug 1975).

We present high-temperature series through tenth order for the susceptibility of all classical scalar models with bilinear nearest-neighbor interactions in the absence of symmetry-breaking fields. As an example of the use of these results we examine the tricritical behavior of triple-well Landau-Wilson models which interpolate between the Blume-Capel and Riedel-Wegner models. The general series are given for the fcc, bcc, and simple cubic lattices. (auth)

SUPERCONDUCTIVITY

4196 (JINR—P4-9087) **One-dimensional Hubbard model.** Kharrasov, M.Kh. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1971. 12p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

An analog of the Bogolyubov inequality was obtained for the case of zero temperature. It was shown that a gap in the energy spectrum of one-particle excitations in the infinite one-dimensional Hubbard model can exist only at zero temperature. (tr-auth)

THEORETICAL PHYSICS

CLASSICAL AND QUANTUM MECHANICS

4197 "Free-space" boundary conditions for the time dependent wave equation. Lindman, E.L. (Los Alamos Scientific Lab., NM). *J. Comput. Phys.;* **18**: No. 1, 66-78(May 1975).

Boundary conditions for the discrete wave equation which act like an infinite region of free space in contact with the computational region can be constructed using projection operators. Propagating and evanescent waves coming from within the computational region generate no reflected waves as they cross the boundary. At the same time arbitrary waves may be launched into the computational region. Well known projection operators for one-dimensional waves may be used for this purpose in one dimension. Extensions of these operators to higher dimensions along with numerically efficient approximations to them are described for higher-dimensional problems. The separation of waves into ingoing and outgoing waves inherent in these boundary conditions greatly facilitates diagnostics. (auth)

4198 "Free-space" boundary conditions for the time-dependent wave equation. Lindman, E.L. (Los Alamos Scientific Lab., NM). *J. Comput. Phys.;* **18**: No. 1, 66-78(May 1975).

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4199 Procedures for the measurement of questions in quantum mechanics. Benioff, P. (Argonne National Lab., IL). *Found. Phys.;* **5**: No. 2, 251-255(Jun 1975).

It is shown that there exist observables A and Borel sets E such that the procedure "measure A and give as output the number I (0) if the A measurement outcome is (is not) in E" does not correspond to a measurement of the proposition observable E/sup A/(E) usually assigned to such procedures. This result is discussed in terms of limitations on choice powers of observers. (auth)

4200 Path integral representation of the reation rate constant in quantum mechanical transition state theory. Miller, W.H. (Univ. of california, Berkeley). *J. Chem. Phys.*; **63**: No. 3, 1166-1172(1 Aug 1975).

Feynman's path integral representation of the Boltzmann operator e/sup -βH/ is used to express the rate constant of a recently formulated quantum mechanical version of transition state theory. By evaluating the path integral in two separate stages, one is able to interpret the result as a generalization of a model suggested several years ago by Johnston and Rapp for handling the nonseparable aspect of tunneling in transition state theory. A Fourier series expansion of the path integral is also developed and this approach has promise for direct numerical evaluation of the quantum rate expression. (auth)

RELATIVITY AND GRAVITATION

4201 Relativistic rotation of axes under successive Lorentz transformations. Weihofen, W.H. (Los Alamos Scientific Lab., NM). *Am. J. Phys.*; **43**: No. 1, 39-46(Jan 1975).

Expressions for the relative rotation of coordinate systems resulting from translational Lorentz transformations are derived heuristically. Both the general case and a useful first-order (in v/c) approximation are treated. The exact results for circular motion and for uniform rectilinear velocity changes are given in practicable form. (6 figures) (auth)

OPTICS

4202 (UCID—16924) **Linear propagation via fourier transforms.** Weaver, H.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 1973. Contract W-7405-Eng-48. 9p. Dep. NTIS $4.50.

It is shown how the Fresnel diffraction equation can be written as a scaled Fourier transform. This Fourier notation is suited for easy integration of common analytical functions. In the case of complicated functions, fast Fourier transform algorithm can be used to numerically integrate the expression. An example is performed for a propagating Gaussian plane wave. The inverse problem is also discussed. (auth)

4203 (UCRL-Trans—10945) **Diffraction theory of the knife-edge test and its improved form, the phase-contrast method.** Zernike, F. Translated from *Physica;* **1**: No. 2, 689-704(1933). 24p. Dep. NTIS $4.50.

The appearance of a concave mirror with arbitrary small deviations in the Foucault knife-edge test and in the new phase-contrast test is calculated on the basis of the Abbe diffraction theory of the optical image. The orthogonal "circular-area polynomials" are found and applied to the diffraction phenomena for the circular mirror. (5 figures) (auth)

MATHEMATICAL PHYSICS

4204 (JINR—E2-8995) **Classification of domains of operator algebras.** Lassner, G.; Timmermann, W. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 20p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The structure of domains of Op*-algebras G(D) is investigated; especially, there is considered the case where the domain D is a Frechet space with respect to a natural topology one obtains a complete classification and description of domain. (auth)

4205 Quantization of fields in accordance with modular statistics. Green, H.S. (Univ. of Adelaide). *Aust. J. Phys.*; **28**: 115-125(1975).

A new generalization of quantum statistics is described, which is different from parastatistics, though it includes Fermi statistics and parafermi statistics of order two. It can be applied to the quantization of nonlinear field theories, without violating the correspondence principle. Like parastatistics, it allows the occupation of a given dynamical state by more than one particle of half-odd-integral spin. A special feature is that quark-like particles are naturally associated in modules, which have many of the characteristics of baryons and mesons. The group theoretical properties of the new statistics, and the implied classification of states, are briefly examined. (auth)

4206 Theorems on wave propagation and uniqueness for a class of nonlinear dissipative materials. Nachlinger, R.R. (Univ. of Houston, Texas); Nunziato, J.W.; Wheeler, L.T. *J. Math. Anal. Appl.*; **51**: No. 2, 449-46C(Aug 1975).

Solutions are examined for general Maxwellian materials containing structured waves. In one dimension, these materials are characterized by the constitutive assumption: sigma = E(F, sigma)F + G(F, sigma). It is shown that if E(F,sigma) and G(F,sigma) satisfy certain hypotheses, then all such waves propagate with bounded speed. It is further shown that this boundedness property implies that there can be at most one solution satisfying the prescribed boundary and initial conditions. (10 refs) (GHT)

CONTROLLED THERMONUCLEAR RESEARCH

PLASMA RESEARCH

4207 (TID—3557-S10) **Controlled fusion and plasma research. A literature search.** Whitson, M.O. (comp.). (Energy Research and Development Administration, Oak Ridge, Tenn. (USA). Technical Information Center). Oct 1975. 512p. Dep. NTIS $13.60.

This bibliography contains 4584 references to journal and report literature that cover information on various aspects of controlled fusion research. Corporate author, personal author, report number, and subject indexes are included. (auth)

PLASMA CONFINEMENT AND HEATING

4208 (COO—2218-38) **Monte Carlo simulation of neutral beam injection into fusion reactors.** Miller, R.L. (Illinois Univ., Urbana (USA)). 15 Sep 1975. Contract AT(11-1)-2218. 31p. Dep. NTIS $5.00.

Motivations and techniques for the Monte Carlo computer simulation of energetic neutral beam injection for fusion reactors are described. The versatility of this approach allows a significantly more sophisticated treatment of charge transfer collision phenomena and consequent effects on engineering design than available from prior work. Exemplary results for a mirror Fusion Engineering Research Facility (FERF) are discussed. (auth)

4209 (LA-UR—75-2030) **Plasma heating by relativistic electron beams: correlations between experiment and theory.** Thode, L.E.; Godfrey, B.B. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 35p. (CONF-751108—6). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

The streaming instability is the primary heating mechanism in most, if not all, experiments in which the beam is injected into partially or fully ionized gas. In plasma heating experiments, the relativistic beam must traverse an anode foil before interacting with the plasma. The linear theory for such a scattered beam is discussed, including a criterion for the onset of the kinetic interaction. A nonlinear model of the two-stream instability for a scattered beam is developed. Using this model, data from ten experiments are unfolded to obtain the following correlations: i) for a fixed anode foil, the dependence of the plasma heating on the beam-to-plasma density ratio is due to anode foil scattering, ii) for a fixed beam-to-plasma density ratio, the predicted change in the magnitude of plasma heating as a function of the anode foil is in agreement with experiment, and iii) the plasma heating tentatively appears to be proportional to the beam kinetic energy density and beam pulse length. For a fixed anode foil theory also predicts that the energy deposition is improved by increasing the beam electron energy γmc^2. Presently, no experiment has been performed to confirm this aspect of the theory. (auth)

4210 (LBL—3262) **Plasma containment in a toroidal bicusp (tormac).** Levine, M.A.; Brown, I.G.; Gallagher, C.C. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Aug 1975. Contract W-7405-ENG-48. 5p. (CONF-750971—1). Dep. NTIS $4.00.

From 3. international conference on alpha beta plasma; Culham, UK (9 Sep 1975).

The stable confinement of a fully ionized, high-beta plasma in a toroidal bicusp (Tormac) is discussed. The bicusp geometry is described along with "shaker" heating by magnetoacoustic waves propagating orthogonal to the internal toroidal magnetic field. (MOW)

4211 (MATT—1088) **Two-energy-component toroidal fusion devices.** Berk, H.L.; Furth, H.P.; Jassby, D.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

Injection of a superthermal ion component into a toroidal plasma can raise the fusion power density to levels considerably higher than those attainable in ordinary one-component plasmas. As a result, energy break-even in D-T can be attained in bulk plasmas with ntau-values as low as $10^{13}cm^{-3}sec$, at temperatures of approximately 5 keV. The optimal energy of the superthermal ion component is in the range 100-200 keV; injection-energy requirements can be reduced by adiabatic compression prior to or during the reaction phase. The appropriate ratio anti GAMMA of fast-ion pressure to bulk-plasma pressure is about 0.5. The stability of two-component tokamak plasmas has been examined, and is found to be favorable for parameters of practical interest. (auth)

4212 (MATT—1092) **Experiments on the Adiabatic Toroidal Compressor.** Bol, K.; Cecchi, J.L.; Daughney, C.C.; DeMarco, F.; Ellis, R.A. Jr.; Eubank, H.P.; Furth, H.P.; Hsuan, H.; Mazzucato, E.; Smith, R.R. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 14p. (IAEA-CN—33/A4-2). Dep. NTIS $4.00.

Magnetic compressional heating of a tokamak discharge has been demonstrated successfully in the Adiabatic Toroidal Compressor (ATC). In addition to these investigations of compressional heating, other basic measurements have been made on ATC recently. These measurements are of interest because the ATC incorporates an air-core transformer and dispenses with the usual copper shell, two features likely to be found on future larger devices with smaller aspect ratios. The following topics will be discussed: (1) characteristics of the uncompressed discharges in ATC, including the dependence of β/sub p/ on discharge parameters, bolometric measurements of the energy balance, measurements of the concentration of impurities; (2) MHD behavior and attempts at stabilization of the m = 2 kink-tearing mode. (auth)

4213 (MATT—1094) **Wave generation and heating in the ST Tokamak at the fundamental and harmonic ion cyclotron frequencies.** Adam, J.; Chance, M.; Eubank, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 10p. (IAEA-CN—33/A3-2). Dep. NTIS $4.00.

Theoretical and experimental investigations are reported of wave generation and heating at the fundamental and the first harmonic of the ion cyclotron frequency. General theoretical considerations are followed by a description of experiments on the ST Tokamak designed to test the feasibility of this heating scheme for providing the additional heating required for toroidal reactor operation. Two rf coils were used in an enlarged section of the ST vacuum vessel to allow operation up to approximately 1 MW of rf power. Wave generation efficiencies of approximately 90 percent were computed from theory and observed experimentally. The ion cyclotron (slow) wave is observed to be strongly damped but the fast hydromagnetic wave is seen to propagate many times around the machine so that standing toroidal eigenmodes are generated. The dependence of the eigenmode resonances on the density and magnetic field agrees closely with a theory based on a cylindrical, cold-plasma model. At $\omega = 2\omega$/sub ic/, with relatively short rf pulses, the ion temperature approximately doubles and increases by approximately 100 eV, corresponding to a heating efficiency of approximately 20 percent. At $\omega = \omega$/sub ic/ the ion temperature increases by only 25 percent under similar conditions. Longer rf pulses lead to a neutral particle influx which tends to constrict the current channel and leads to MHD instabilities. The impurity component of this influx also leads to enhanced ion heating by decreasing the ion-electron equipartion time. The temperature increases quoted are for conditions where the effect of this neutral influx was negligible. (auth)

4214 (MATT—1113) **Fast-wave heating of a two-component plasma.** Stix, T.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Feb 1975. Contract AT(11-1)-3073. 56p. Dep. NTIS $6.00.

The use of the compressional hydromagnetic mode (also called the magnetosonic or, simply, the fast wave) is examined in some detail with respect to the heating of a tritium plasma containing a few percent deuterium. Efficient absorption of wave energy by the deuteron component is found when $\omega = \omega$/sub c/ (deuterons), with Q/sub wave/ greater than or equal to 100. The dominant behavior of the high-energy deuteron distribution function is found to be f(v) approximately exp[3/2) $\int$/sup v/ dv less than Δv greater than/less than(Δv/sub perpendicular to/)^{2}greater than], where [Δv] is the Chandrasekhar-Spitzer drag coefficient, and [(Δv/sub perpendicular to/)$^2 v$] is the Kennel-Englemann quasilinear diffusion coefficient for wave—particle interaction at the deuteron cyclotron frequency. An analytic solution to the one-dimensional Fokker—Planck equation, with rf-induced diffusion, is developed, and using this solution together with Duane's fit to the D-T fusion cross-section, it is found that the nuclear fusion power output from an rf-produced two-component plasma can significantly exceed the incremental (radiofrequency) power input. (auth)

4215 (ORNL-TM—4843) **Dynamic overall energy balance of clean and impurity-contaminated tokamak reactors.** Hiraoka, T.; McNally, J.R. Jr.; Steiner, D. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 124p. Dep. NTIS $5.45.

The energy balance of fusion reactors was investigated from the viewpoints of both physics and engineering requirements, but most of the previous investigations have been static analyses. On the other hand, dynamic behavior was studied for clean plasma. The energy balance for impurity-contaminated reactors should be investigated dynamically because impurities shorten the burning time considerably. Moreover, it is necessary to evaluate the energy balance of the whole reactor system, including engineering aspects that support plasma burning over a complete cycle. The reactor system to be analyzed should be self-consistent with regard to plasma-physics and reactor-engineering parameters, and realistic engineering limitations must be imposed. A zero-dimensional model is assumed, and the dynamic overall energy balance is investigated over a complete cycle (from the initial heating stage until the beginning of the next discharge). Simultaneous time-dependent differential equations are solved for particle density and ion and electron temperatures based on trapped particle mode losses. (auth)

4216 (UCID—16914) **Compact high-energy neutral beam system.** Anderson, O.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Aug 1975. Contract W-7405-Eng-48. 11p. Dep. NTIS $4.50.

Pumping requirements for handling excess gas in a CTR high-energy neutral beam system are substantially reduced by using a cesium jet to act simultaneously as the charge-changing mechanism and as a reflector for excess deuterium gas. Practical applications and problems such as cesium contamination of the D^+ source are discussed. (auth)

4217 (UCRL—77152) **Self-consistent microwave plasma heating rates.** Ensley, D.L.; White, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. 31p. (CONF-751108—11). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Under conditions within a hot overdense plasma corona where the field frequency is much less than the electron plasma frequency and the field period is much less than the hydrodynamic expansion time it is shown that electron field reversal heating can exceed the combined classical heating rates due to inverse bremsstrahlung (skin effect) and field pressure (PdV) by a factor approximately v/sub e//2v/sub i/ (half the ratio of electron and ion thermal velocities). In particular this rate can exceed the inertial expansion cooling rate at a collisionless corona density of approximately 1 percent solid core density and could be realized experimentally at core temperatures approximately 3—5 keV and microwave field intensities approximately 1 MG. (auth)

4218 **Alpha particle energetics and neutral beam heating in Tokamak plasmas.** Mcalees, D.G. Madison, WI; Univ. of Wisconsin (1974). 144p. University Microfilms Order No. 74-27,750.

Thesis (Ph. D.).

In this work two key physics areas fundamental to tokamak plasmas have been analyzed in detail. Both center around plasma and particle dynamics and are critical to the success of deuterium-tritium fueled fusion power systems as they are presently envisioned. The energetic aspects of the 3.5 MeV alpha particles produced in D—T fusion events are examined and physical phenomena which can be expected to occur in future devices containing alphas are predicted. The model of the alpha particle dynamics includes toroidal magnetic field gradient and curvature drifts and motion along the magnetic field lines. Guiding center motion of alpha particles in various size plasma systems is analyzed. A model is developed to determine the energy density deposition rate profiles for neutral beam injection into a tokamak. The heating profiles in the background plasma due to neutral beam injection and alpha particle production are coupled to study the startup of a large CTR reactor. A two-fluid space time computer model is used to simulate the overall plasma behavior. The simulation model includes neoclassical ion conduction, pseudoclassical electron conduction, electron-ion rethermalization, bremsstrahlung and synchrotron radiation, ohmic heating, alpha particle and neutral beam heating terms. Questions of beam energy deposition profiles, energy requirements for neutral penetration into the plasma, and beam power required to achieve ignition or prescribed heatup rates are examined. The analysis is primarily for the 5000 MW(th) conceptual fusion reactor UWMAK-I studied by the University of Wisconsin. Typically, beam energies of several hundred kilovolts and powers of approximately 50 MW provide adequate penetration and ignition times in the range of 2 to 10

seconds. The sensitivities of the time required to achieve ignition and resulting heatup rates to changes in injection energy (100 to 500 keV) and beam power (10 to 75 MW) are also determined. (Diss. Abstr. Int., B)

4219 (ERDA-tr—69) **Investigation of the interaction of high-frequency oscillations in the decimeter range with plasma in the TOKAMAK TM-3 unit.** Alikaev, V.V.; Arsen'ev, Yu.I.; Bobrovskii, G.A.; Poznyak, V.I.; Razumova, K.A.; Sokolov, Yu.A. Translated from *Zh. Tekh. Fiz.*; **45**: No. 3, 523-526(1975). 8p. Dep. NTIS $4.00.

The phejomena arising during the interaction of high-frequency radiation with plasma, primarily under the conditions ω/sub He/ greater than ω greater than or equal to √ω/sub He/ω/sub Hi/ and ω/sub pe greater than ω greater than or equal to ω/sub pi/ was studied. Considerable absorption of the high-frequency power was observed throughout the entire range of parameters characterizing the Tokamak plasma. This absorption was accompanied by ion heating, additional displacement of the plasma column, and the appearance of hard x-ray radiation. (auth)

4220 **Radiation from plasmas in the ST-Tokamak.** Bretz, N.; Dimock, D.; Greenberger, A.; Hinnov, E.; Meservey, E.; Stodiek, W.; Von Goeler, S. (Princeton Univ., NJ). pp 55-64 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Quantitative vacuum ultraviolet (UV) measurements (lambda greater than or equal to 100 A) of various ST-Tokamak discharges show that the atom density of metal impurities is about 0.1 to 1.5 percent of the electron density and that the atom density of oxygen is about 1 to 10 percent. These concentrations yield an effective ionic charge, anti Z, consistent with the measured current, voltage, and profiles of electron temperature. The radial distribution of high-Z material is obtained from x-ray measurements in the range 1 A less than or equal to lambda less than or equal to 4 A; from these one concludes that there is no extreme concentration of high-Z material in the center, but cannot exclude variations within a factor of 2. The x-ray spectrum is dominated by recombination; using bremsstrahlung and recombination calculations the value of anti Z derived from x-ray intensity is comparable with the value from conductivity. An instrument is described for making measurements in the extreme UV region (5 less than lambda less than 20 A). In this range strong emission has been observed (radiated power about 10 percent of power input in the center), which is attributed to line emission from heavy-metal (Fe or Mo) ions which are produced only at an electron temperature above about 1200 eV; the very narrow radial profile of observed intensity is consistent with measured temperature and density profiles. Rough estimates of the concentration of heavy metals required to account for the radiated power are consistent with vacuum UV and x-ray data. (auth)

4221 **Wave generation and heating in the ST-Tokamak at the fundamental and harmonic ion cyclotron frequencies.** Adam, J.; Chance, M.; Eubank, H. (Princeton Univ., NJ). pp 65-73 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Theoretical and experimental investigations of wave generation and heating at the fundamental and the first harmonic of the ion cyclotron frequency are reported. General theoretical considerations are followed by a description of experiments on the ST-Tokamak designed to test the feasibility of this heating scheme for providing the additional heating required for toroidal reactor operation. Two rf-coils were used in an enlarged section of the ST vacuum vessel to allow operation up to ~ 1 MW of rf-power. Wave generation efficiencies of ~ 90 percent were computed from theory and observed experimentally. The ion cyclotron (slow) wave is observed to be strongly damped, but the fast hydromagnetic wave is seen to propagate many times around the machine so that standing toroidal eigenmodes are generated. The dependence of the eigenmode resonances on the density and magnetic field agrees closely with a theory based on a cylindrical, cold-plasma model. At ω = 2ω/sub iC/, with relatively short rf-pulses, the ion temperature approximately doubles and increases by ~ 100 eV, corresponding to a heating efficiency of ~ 20 percent. At ω = ω/sub iC/, the ion temperature increases by only 25 percent under similar conditions. Longer rf-pulses lead to a neutral-particle influx which tends to constrict the current channel and leads to MHD-instabilities. The impurity component of this influx also leads to enhanced ion heating by decreasing the ion-electron equipartion time. The temperature increases quoted are for conditions where the effect of this neutral influx was negligible. (auth)

4222 **Neutral-beam heating in the adiabatic toroidal compressor.** Bol, K.; Cecchi, J.L.; Daughney, C.C. (Princeton Univ., NJ). pp 77-82 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Results are given for tangential injection into ATC of two 15-keV neutral beams with net power up to 100 kW. The ion temperature rise exceeds 100 eV, consistent with theoretical expectations. Fast-ion drag rates and pitch-angle scattering have been measured, the latter to determine Z/sub eff/. Injection was also made at 83 and 97° to the plasma current. At 83° some ion heating is observed; at 97° the heating is negligible. The fast-ion energy distributions, observed tangentially, show the severity of the "loss-region" for counter-circulating particles. (auth)

4223 **Experiments on the Adiabatic Toroidal Compressor.** Bol, K.; Cecchi, J.L.; Daughney, C.C. (Princeton Univ., NJ). pp 83-97 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Magnetic compressional heating of a tokamak discharge has been demonstrated successfully in the Adiabatic Toroidal Compressor (ATC). In addition to these investigations of compressional heating, other basic measurements have been made on ATC recently. These measurements are of interest because the ATC incorporates an air-core transformer and dispenses with the usual copper shell, two features likely to be found on future larger devices with smaller aspect ratios. The following topics are discussed: (1) characteristics of the uncompressed discharges in ATC, including the dependence of β/sub p/ on discharge parameters, bolometric measurements of the energy balance, measurements of the concentration of impurities; (2) MHD-behavior and attempts at stabilization of the m = 2 kink-tearing mode. (auth)

4224 **Plasma confinement in the ORMAK device.** Berry, L.A.; Callen, J.D.; Clarke, J.F. (Oak Ridge National Lab., TN). pp 101-112 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Experiments in two different operating regimes of the Oak Ridge Tokamak (ORMAK), with Ohmic heating, are discussed. The confinement characteristics of a broad-profile discharge in a low-density regime and a peaked-profile discharge at high density are described in detail. Through charge-exchange analysis, particle diffusion coefficients for these discharges are evaluated, and it is shown that the particle diffusion is not a significant energy loss for the present operating conditions. Detailed examination of the radial power flow for the ions indicates that the dominant loss from the core is heat conduction, the form (and magnitude) of which is consistent with the neoclassical predictions, provided local collision frequencies are enhanced by an amount comparable to that inferred from the resistance anomaly. Examination of the electron power flow suggests anomalous behavior of the electrons. However, for the broad-profile discharges, average confinement parameters, such as β/sub p/ or the energy confinement time, are reasonably consistent with pseudoclassical predictions. With increasing electron density, overall confinement improves, in spite of profile peaking (β/sub p/ approximately anti n/sub e//I). The resistance anomaly is observed to scale roughly as I/sup alpha//anti n/sub e/, where α approximately 1. At high densities, the volume-averaged effective ionic charge, (Z/sub eff/)/sub res/, inferred from resistance anomaly, shows a rough agreement with (Z/sub eff/)/sub meas/, inferred from direct measurements (vacuum-ultraviolet spectroscopy, soft-X-ray, and charge-exchange analysis of pitch-angle-scattered fast ions in the neutral-beam injection). However, with decreasing densities, (Z/sub eff/)/sub res/ becomes (by a factor greater than or equal to 2) higher than (Z/sub eff/)/sub meas/, suggesting that the possibility of turbulent enhancement cannot be excluded. (auth)

4225 **Neutral beam injection experiments in ORMAK.** Berry, L.A.; Bush, C.E.; Dunlap, J.L.; Edmonds, P.H.; Jernigan, T.C.; Lyon, J.F.; Murakami, M.; Wing, W.R. (Oak Ridge National Lab., TN). pp 113-124 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Two energetic (each approximately 26 kV, 100 kW) neutral beams were used to supplement the larger Ohmic heating of the Oak Ridge Tokamak (ORMAK) plasma. Long, constant discharge-current times and beam pulse lengths permitted an essentially equilibrium study of both plasma heating and other effects due to neutral beam injection. Both coinjection (beam parallel to the discharge current) and counterinjection (anti-parallel to the discharge current) were studied. Injection perturbs the plasma density and hence the electron-ion heat transfer, an effect which must be taken into account in evaluating the ion heating due to beam power input. The observed ion temperature increases with coinjection are in agreement with theoretical predictions both in magnitude (ΔT/sub i//T/sub i/ ranging from 40 to 10 percent) and in scaling with plasma density. Measurements of parallel and perpendicular beam ion energy distributions are in agreement with theory, indicating little charge-exchange beam power loss, an effective ionic charge (Z) approximately 4, and significant beam energy transfer to the plasma. While net electron heating is sometimes observed with coinjection, the main effect of injection on electrons is to alter the radial distributions of electron temperature and density. Counterinjection was found to be much less effective than coinjection in plasma heating and to have a generally deleterious effect on the discharge parameters, stability, and confinement. (auth)

4226 Theoretical studies of plasma confinement in magnetic mirrors. Rensink, M.E.; Fowler, T.K.; Freis, R.P. (Univ. of California, Livermore). pp 311-319 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The plasma confinement parameter (n tau) and the maximum β consistent with ideal MHD stability are computed for various values of the mirror ratio R and ion-source injection angle $theta_0$. The mathematical model that yields this information is the velocity-space Fokker—Planck equation for the ion and electron distribution functions. For an idealized plasma configuration, the modification of the magnetic field due to finite β is calculated. The computation of self-consistent, finite-β plasma equilibrium is given with application to mirror magnetic wells. The omnigenous nature of some non-axially-symmetric cells is illustrated, and the results of solving magnetic differential equations on a Eulerian grid to compute field line integrals are shown. (auth)

4227 Intense-neutral-beam research and development. Baker, W.R.; Berkner, K.H.; Copper, W.S.; Ehlers, K.W.; Kunkel, W.B.; Pyle, R.V.; Strarns, J.W. (Univ. of California, Berkeley). pp 329-337 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The LBL "10-ampere" source, which delivered 10-A, 20-keV, 20-ms deuterium beams into the LLL 2XII mirror experiment, has been scaled up by a factor of 5. This "50-ampere" source and its operation are discussed in some detail. It produces a 10-ms, 20-keV deuterium ion beam of approximately 75 A (1.5 MW), which is converted to energetic neutrals with about 90 percent efficiency in a close coupled neutralizer; 67 equivalent amperes (1.34 MW) of ions and neutrals are delivered in $+ -2^0 \times + 4^0$, of which 47 A (0.94 MW) are within $+-1^0 \times +-2^0$. Some of the modifications of the original 10-A source are discussed, too: the use of curved grids to decrease beam divergence, the addition of vanes to reduce gas flow from the source, and staging to higher energies by adding another 7 x 7 cm electrode to give two accelerator gaps in series. Finally, progress in the computational program on the optimization of ion extractors is briefly described. (auth)

4228 Plasma production and confinement in the Baseball II mirror experiment. Anderson, O.A.; Birdsall, D.H.; Damm, C.C. (Univ. of California, Livermore). pp 379-389 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The problem of plasma build-up in a steady-state magnetic-mirror field is being explored in the Baseball II experiment. Methods under investigation utilize neutral-beam injection either with or without a target plasma. Results are reported for build-up starting from a high vacuum, without a target. To reduce the likelihood of microinstability, an ion distribution broadened by Coulomb scattering is obtained. With injection at energies less than 2 keV in a high-vacuum environment, the mirror losses were found to substantially exceed charge-exchange losses, indicating a broadened ion distribution. However, the threshold density for ion-cyclotron instability was no higher than in previous experiments that were dominated by charge exchange. The onset of instability is observed to depend on beam geometry, and instability signals are usually absent shortly after beam injection ceases. The spatial and temporal distribution of anomalous losses is related to potential perturbations rotating at frequencies near the ion grad-B drift. Anomalous losses increase rapidly as the injected beam increases limiting the density to 3-5 x 10^9 cm^{-3}. A pulsed hydrogen discharge in minimum -B geometry for use as a target plasma was also investigated. Densities of 10^{13} to 10^{14} cm^{-3} have been measured in a 5-cm-diameter discharge with electron temperature of 5-15 eV. Calculations show satisfactory hot-plasma build-up with 50-A pulsed injection. (auth)

4229 Laser-initiated target experiment (LITE). Haught, A.F.; Ard, W.B.; Fader, W.J.; Jong, R.A.; Mensing, A.E.; Polk, D.H.; Tomlinson, R.G.; Woo, J.T. (United Aircraft Research Labs., East Hartford, CT). Contract AT(11-1)-2277. pp 391-399 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The UARL Laser Initiated Target Experiment (LITE) is investigating the use of neutral beam injection onto a high-density target plasma to create and sustain a hot, dense, steady-state plasma in mirror geometry. The moderate-temperature (less than or equal to 1 keV), high-density, mirror-confined target plasma for this program is generated by laser beam heating of a small, solid particle of LiH within a minimum-B magnetic field. The LITE system is designed to inject a 0.5 A equivalent beam of 10 keV H^0 neutrals onto the approximately 100 cm^2 projected area of the confined target. Fokker-Planck and rate-equation calculations show that the target plasma will be heated by charge exchange and maintained by ionization of the injected beam to form a steady-state injection-sustained 10-keV plasma at a density greater than 10^{12} cm^{-3}. (auth)

4230 Electrostatic trapping of high-Z impurity ions, and alpha-particle diffusion in tokamak reactors. Hazeltine, R.D. (Univ. of Texas, Austin); Ware, A.A.; Sigmar, D.J.; Hirshman, S.P.; McCune, J.E.; Crume, E.C.; Hogan, J.T.; Clarke, J.F. Contract AT(11-1)-3070. pp 589-603 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

New neoclassical effects are reported which result from the nonuniform density of impurity ions on a magnetic surface. Nonuniformity arises partly from toroidal effects directly and partly from the associated electrostatic potentials. There is a new pinch effect involving passing particles and a corresponding bootstrap current. There is no increase in electron diffusion; the diffusion driven by the friction of the new bootstrap current is cancelled by the interaction of the Pfirsch-Schlueter current with the variable part of the resistivity. At the high collision frequency end of the plateau regime the pressure gradient needed to balance the combined pinch effects is substantially increased; this will help explain the increase in —dT/sub e//dr with decreasing radius observed in ST. Thermalized α-particle and fuel ion diffusion in a reactor-like tokamak plasma is investigated. The coupled continuity equations for n/sub alpha/ and n/sub i/, with the fluxes GAMMA sub alpha/ and GAMMA sub i/ given by a previously developed impurity theory in the banana regime, are discussed analytically and solved numerically. If the superthermal α-particles remain near their birth-flux surfaces during slow-down, n/sub α/ is strongly coupled to n^2/sub i/ (sigma /sub f/v) and γ/sub α/ is outward, GAMMA sub i/ inward. This enables refueling from the edge. If the shape of n/sub α/ is decoupled from n^2/sub i/ (sigma sub f/v), GAMMA sub α/ is inward and GAMMA sub i/ outward, until Taylor's impurity equilibrium is reached. Using distributed refuelling sources, one can nevertheless achieve steady state profiles with tolerable α-particle concentration. (auth)

4231 Neutral beam injection into tokamaks. Callen, J.D.; Colchin, R.J.; Fowler, R.H.; McAlees, D.G.; Rome, J.A. (Oak Ridge National Lab., TN). pp 645-658 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The theory of the plasma modifications induced by neutral beam injection into a tokamak is developed in detail. The system is treated as a three-component plasma: fast ions, background plasma ions and electrons. The fast-ion treatment includes: (1) the initial fast-ion spatial distribution; (2) energy and momentum transfer from the fast ions to the background plasma ions and electrons in the presence of impurities, charge exchange and an electric field; (3) a loss region in velocity space due to drift orbits that make large outward radial excursions for certain pitch-angle ranges; and (4) pitch-angle scattering into the loss region during the fast-ion slowing-down process. The degree to which this fast-ion component can model alpha particles in a reactor is discussed. The changes that the momentum and energy inputs from the fast ions induce in the plasma transport equations are derived. The resultant macroscopic plasma perturbations are calculated and, except for the density change, found to compare favorably with experimental results. The profile changes induced by the current perturbation and central electron heating complicate the analysis and comparison with experiment. (auth)

4232 Plasma heating and losses in toroidal multipole fields. Armentrout, C.J.; Barter, J.D.; Breun, R.A. (Univ. of Wisconsin, Madison). pp 89-96 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

The heating and loss of plasmas have been studied in three pulsed, toroidal multipole devices: a large levitated octupole, a small supported octupole and a very small supported quadrupole. Plasmas are produced by gun injection and heated by electron and ion cyclotron resonance heating and Ohmic heating. Electron cyclotron heating rates have been measured over a wide range of parameters, and the results are in quantitative agreement with stochastic heating theory. Electron cyclotron resonance heating produces ions with energies larger than predicted by theory. With the addition of a toroidal field, Ohmic heating gives densities as high as 10^{13} cm^{-3} in the toroidal quadrupole and 10^{12} cm^{-3} in the small octupole. Plasma losses for $n = 5 \times 10^{9}$ cm^{-3} plasmas are inferred from Langmuir-probe and Fabry-Perot interferometer measurements, and measured with special striped collectors on the wall and rings. The loss to a levitated ring is measured by using a modulated light beam telemeter. The confinement is better than Bohm but considerably worse than classical. Low-frequency convective cells which are fixed in space are observed. These cells around the ring are diminished when a weak toroidal field is added, and loss collectors show a vastly reduced flux to the rings. Analysis of the spatial density profile shows features of B-independent diffusion. The confinement is sensitive to some kinds of d. c. field errors, but surprisingly insensitive to perturbations of the a. c. confining field. (auth)

4233 Diffusions of dc octopole plasmas in the trapped-electron regime. Tamano, T.; Hamada, Y.; Moeller, C.; Ohkawa, T.; Prater, R. (General Atomic Co., San Diego, CA). Contract AT(04-3)-167. pp 97-102 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Diffusions of collisionless plasmas were investigated in the dc Octopole. Three types of diffusions were observed in this regime. One is neoclassical diffusion which occurs at low electron temperatures (T/sub c/ < 0.5 eV) and low poloidal magnetic fields. Another diffusion is thermal fluctuation diffusion which takes place when the plasma dielectric constant is small, i.e., in low densities and high magnetic fields. When electrons are heated above 0.5 eV, the third diffusion mode appears. The plasma lifetime in this mode is proportional to the reciprocal of the electron temperature and to the strength of the poloidal magnetic field, but is independent of plasma density and the toroidal magnetic field. Thus, the diffusion is called "poloidal Bohm" diffusion since the scaling is similar to Bohm scaling except it has the strength of the poloidal magnetic field instead of the total magnetic field. The magnitude of the plasma lifetime is 500 ~ 1000 times longer than a "poloidal Bohm Time". Judging from the magnitude of the diffusion coefficient, the cause of this diffusion is likely to be a weak turbulence due to the presence of trapped electrons. It is also noted that the poloidal Bohm scaling seems to fit the results of plasma confinement times of tokamaks and spherators. (auth)

4234 Plasma confinement and heating in the ELMO Bumpy Torus (EBT). Dandl, R.A.; Eason, H.O.; Guest, G.E.; Hedrick, C.L.; Ikegami, H.; Nelson, D.B. (Oak Ridge National Lab., TN). pp 141-149 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

The ELMO Bumpy Torus (EBT) is a toroidal magnetic trap in which microwave heating is used to produce steady-state, high-beta plasmas. The confined plasma consists of an annular, mirror-confined, relativistic-electron component localized near the midplane of each of the 24 identical sectors of EBT; and a less energetic circulating ("toroidal") component with more nearly isotropic pressure. The plasma is formed and heated (and maintained in steady state) by two 18-GHz klystron amplifiers producing 30 kW (cw); two travelling-wave amplifiers at 55 GHz producing 10 kW (cw); and 5 kE (cw) additional power at 10.6 GHz. Depending on ambient gas pressures, three distinct modes of plasma behaviour are observed: a cold-plasma mode (C-Mode) at high pressure; a quiet mode with significant stored energy at intermediate pressures (T-Mode); and a mode with large stored energy but high fluctuation levels at low pressure (M-Mode). In the T-Mode typical parameters are: for the toroidal component: n/sub e/ approximately 1-3 x 10^{12}/cm^{3}; T/sub e/ greater than 100 eV; T/sub i/less than 75 eV; for the annular component: n/sub e/ approximately equal to 8 x 10^{10}/cm^{3}; T/sub e/ approximately equal to 900 keV; β approximately equal to 0.4. The observed stability is consistent with a body of theoretical results developed for EBT while the observed confinement suggests that neoclassical transport mechanisms may dominate in the T-Mode, where observed particle-replacement times are 10's of milliseconds. (auth)

4235 Electrostatic and electromagnetic confinement of plasmas and the phenomenology of relativistic electron beams. Conference held at New York, NY, March 5—7, 1974. Marshall, L.C.; Sahlin, H.L. (eds.). *Ann. N.Y. Acad. Sci.*; **251**: 1-711(8 May 1975).

Separate abstracts were prepared for the papers and they are included in this issue. The papers cover information on the electromagnetic confinement of plasma, electrostatic confinement, interaction of relativistic electron beams with targets and plasmas, electromagnetic and electrostatic confinement, relativistic electron beams, new techniques, and original new approaches. (MOW)

4236 Mass analysis of low-energy ions in the Baseball II plasma containment experiment. Goodman, R.K. (Univ. of California, Livermore). *Nucl. Fusion;* **15**: No. 4, 643-650(Aug 1975).

In a magnetic mirror plasma experiment, the plasma containment time is often limited by the charge exchange of energetic plasma ions with thermal gas. The low-energy ions that result from the charge exchange are not trapped by the magnetic field, but emerge through the mirrors and follow the field lines with an energy of the order of the plasma potential. Mass identification of these ions helps in locating and eliminating the source of the charge-exchange gas. To perform this identification, a modified quadrupole mass spectrometer is operated in the fringe magnetic field of the Baseball II plasma experiment. From the resulting spectra an estimate is made of the density of each component of the thermal gas. For various experimental conditions of Baseball II, component density estimates and time-resolved mass analyses are given. The mass spectrometer and its operation are also described. (auth)

4237 Measurement of the energy balance in ATC tokamak. Hsuan, H.; Bol, K.; Ellis, R.A. (Princeton Univ., NJ). *Nucl. Fusion;* **15**: No. 4, 657-661(Aug 1975).

Gross properties of the energy balance in the ATC tokamak were investigated. During the quasi-steady state phase of a normal discharge, the major part of the energy loss was found to be to the limiters. Radiation and charge-exchange play minor roles during this quasi-steady state phase, but are nevertheless the dominant loss mechanisms at the termination of a discharge and account for a substantial portion of the stored poloidal magnetic energy associated with the plasma current. (auth)

4238 Pressure profiles in a thermonuclear plasma sheath containing energetic α-particles. Enoch, J. (Los Alamos Scientific Lab., NM). *Nucl. Fusion;* **15**: No. 4, 671-675(Aug 1975).

The pressure balance equation for a plasma sheath made up of fictitious fuel ions, electrons and α-particles is solved. The ions are assumed to be electrostatically confined which turns out to imply quasi-neutrality for sufficiently diffuse boundaries. The α-particles are assumed to satisfy the Vlasov equation and to be produced mono-energetically with a spatial source distribution proportional to the square of the fuel ion density. The final steps of the calculation are performed numerically and results for a few sets of parameters are shown. The α-particle pressure is dominant in all regions of space for cases of practical interest. (auth)

4239 Creation of transient high-density plasmas by convergent neutral beams. Post, R.F.; Marx, K.D.; Eggens, C.J. (Univ. of California, Livermore). *Nucl. Fusion;* **15**: No. 4, 701-703(Aug 1975).

The technique uses an array of inwardly directed pulsed neutral beam sources located on a spherical surface. The beam is programmed so that particles launched late in time tend to catch up with earlier ones. Calculations of beam dynamics are given. (MOW)

4240 Beam self-trapping and dynamics of laser-induced magnetoplasmas. Loter, N.G.; Cohn, D.R.; Halverson, W.; Lax, B. (Francis Bitter National Magnet Laboratory, Massachusetts Institute of Technology, Cambridge, Massachusetts 02139). *J. Appl. Phys.;* **46**: No. 8, 3302-3309(Aug 1975).

Spatially and temporally resolved measurements of transmitted laser radiation, radial density profiles, and plasma dynamics indicate beam self-trapping in CO_2 laser-induced helium plasmas in strong longitudinal magnetic fields. Trapping is observed for the cases of $\beta>1$, $\beta\cong1$, and $\beta<1$. Longitudinal plasma growth occurs principally by breakdown waves and weak radiation-supported detonation waves.

4241 Collisional losses from a mirror machine with an end stopper. McHarg, B.B. Jr.; Oakes, M.E. (Department of Physics, University of Texas, Austin, Texas 78712). *Phys. Fluids;* **18**: No. 8, 1059-1065(Aug 1975).

Collisional losses from the ends of a mirror machine place substantial restrictions on the confinement time of a plasma in such a device. One method proposed to improve the viability of a mirror machine reactor is to reduce the end losses by some means other than the magnetostatic field. Such a device is called an end stopper and it has the effect of changing the loss cone of the usual mirror machine into a loss hyperboloid (two sheet). The end losses from a mirror machine with an ideal, perfectly reflecting end stopper are studied by numerically solving the Fokker—Planck equation with appropriate mirror-end stopper boundary conditions. The mirror and end stopper are assumed to be a square well system and only decay of the ions from the system is considered.

4242 (UCRL-Trans—10954) **Compression of a dense toroidal plasma with $\beta > 1$ by a gas piston.** Kurtmullaev, R.Kh.; Lunin, A.L.; Semenov, V.N. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). Nov 1975. Translation of a Russian report. 17p. Dep. NTIS $4.50.

A method is considered for creating a toroidal plasma in a system with nonmagnetic confinement. The process of gas breakdown, formation of the toroidal structure, and heating of the plasma takes place in two stages. Initially, a gas pressure is created in the chamber in the range corresponding to the usual conditions for a gas discharge (n_0 approximately 10^{16} cm^{-3}). The gas breaks down, a closed magnetic structure forms, and initial heating to a temperature of 1 to 2 keV takes place. Some calculations are described. (MOW)

PLASMA DIAGNOSTICS

4243 (LA-UR—75-1542) **Characteristics of high-density theta pinches seeded with selected high-Z elements.** Thomson, D.B.; Jones, L.A.; Bailey, A.G.; Engleman, R. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944—18). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Atomic processes in high-temperature plasmas are vital in controlled fusion research and in opacity calculations. A program at Los Alamos to observe radiation from a high-Z-seeded theta pinch has the goal of studying these processes. A 60-kV, 180-kJ capacitor bank, crowbarred at peak current, produced a B/sub z/ field of 90 kG at T/4 = 3.0 μs in a 25-cm-long, 8.2-cm-i.d. theta coil. The theta pinch, called Scyllar, has been operated with hydrogen, deuterium, or helium, seeded with a few percent of Ne, CO_2, $Fe(CO)_5$, or other elements. Radiation in the VUV range is observed with a 2.2-m grazing incidence vacuum spectrograph. Diagnostics have included pulsed laser holographic interferometry, time-resolved observations of He II 4686 A line profiles, and two-foil soft x-ray temperature measurements. For diagnostics development, the bank has been operated at 1/3 capacitance with a field of 45 kG at T/4 = 2.0 μs. Characteristics of the seeded plasmas are summarized. (auth)

4244 (LA-UR—75-2077) **Simple, versatile system for digitizing and reducing data in photographic form.** Henins, I.; Marshall, J.; Sherwood, A.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 7p. (CONF-751125—59). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The data reduction system used on the Implosion Heating Experiment at LASL is described. The large number of fast diagnostic signals being recorded on this small experiment makes direct analog to digital conversion impractical at the present time. Therefore data acquisition is by the usual Polaroid photographs of scope traces. These data are digitized and reduced using a system built around a Hewlett Packard Model 9830 desk calculator equipped with a digitizer and plotter. An optical arrangement is described which allows a scope trace to be conveniently digitized well within the accuracy required. The digitized data can be processed as necessary with the desk calculator, plotted as desired, and stored on a magnetic tape cassette. It is believed that this system has merit for other small experiments where simplicity and versatility are desirable. (auth)

4245 (MATT—1085) **Measurement of the development and evolution of shock waves in a laser-induced gas breakdown plasma.** Chu, T.K.; Johnson, L.C. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 28p. Dep. NTIS $4.50.

Space- and time-resolved interferometric measurements of electron density in CO_2-laser produced plasmas in helium or hydrogen are made near the laser focal spot. Immediately after breakdown, a rapidly growing region of approximately uniform plasma density appears at the focal spot. After a few tens of nanoseconds, shock waves are formed, propagating both transverse and parallel to the incident laser beam direction. Behind the transverse propagating shock is an on-axis density minimum, which results in laser-beam self trapping. The shock wave propagating toward the focusing lens effectively shields the interior plasma from the incident beam, because the lower plasma temperature and higher plasma density in the shock allow strong absorption of the incident beam energy. By arranging the laser radiation-plasma interaction to begin at a plasma vacuum interface at the exit of a free-expansion jet, this backward propagating shock wave is eliminated, thus permitting efficient energy deposition in the plasma interior. (auth)

4246 (SAND—75-5415) **Laser velocimeter data acquisition, processing, and control system.** Croll, R.H. Jr.; Peterson, C.W. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 8p. (CONF-750919—2). Dep. NTIS $4.50.

From 6. international congress on insturmentation in aerospace simulation facilities; Ottawa, Canada (22 Sep 1975).

The use of a mini-computer for data acquisition, processing, and control of a two-velocity-component dual beam laser velocimeter in a low-speed wind tunnel is described in detail. Digital stepping motors were programmed to map the mean-flow and turbulent fluctuating velocities in the test section boundary layer and free stream. The mini-computer interface controlled the operation of the LV processor and the high-speed selection of the photomultiplier tube whose output was to be processed. A statistical analysis of the large amount of data from the LV processor was performed by the computer while the experiment was in progress. The resulting velocities are in good agreement with hot-wire survey data obtained in the same facility. (auth)

4247 (UCID—16939) **Calculations for x-ray diagnostics in 2XIIB.** Garner, G.; Logan, B.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 18 Sep 1975. Contract W-7405-Eng-48. 57p. Dep. NTIS $5.50.

A calculation of x-ray emission in 2XIIB for various plasma models is presented, comparing T/sub e/ obtained from measured x-ray transmission through various foils to T/sub e/ obtained from Thomson scattering. The three models used are: pure bremsstrahlung radiation with a full Maxwellian electron distribution; bremsstrahlung, recombination, and line radiation with impurities and a full Maxwellian electron distribution; and bremsstrahlung, recombination, and line radiation with impurities and a cutoff electron distribution. The last model was found to give temperatures most consistent with Thomson scattering and absolute intensities consistent with the intensities measured, indicating impurities and ambipolar cutoffs for electrons are present in 2XIIB. (auth)

4248 Studies on noncircular cross-section toroids in the Doublet II and IIA device. Ohkawa, T.; Baker, C.C.; Brooks, N.H. (General Atomic Co., San Diego, CA). pp 281-290 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Studies of confinement of toroidal plasmas with noncircular cross sections have been carried out in the Doublet II device. The motivation for these studies is the expectation that noncircular cross-section devices can operate at significantly higher values of beta than circular cross-section devices. A requirement for the

realization of this potential is that noncircular cross-section toroids must obtain values of the safety factor and the poloidal beta comparable to those obtained in circular cross-section toroids. The experimental results from Doublet II substantiate this expectation. Electron temperatures up to 1100 eV and ion temperatures up to 525 eV were measured, yielding values of beta in the range of 1 percent. These results were obtained for plasma currents in the range 90—210 kA and the toroidal magnetic field was below 10 kG. To obtain plasmas with noncircular cross sections, it is necessary to establish special boundary conditions for the poloidal magnetic field. These boundaries can be established by conducting walls (field shapers) or by field coils with properly controlled currents and voltages. Some aspects of plasma control are simplified by the use of field shapers, but little configurational flexibility is possible, and diagnostic access is difficult. Therefore the Doublet II device was modified by replacing the field shaper with field coils. The modified device, called Doublet IIA, has been completed and is in the early stage of operation. (auth)

4249 **Computer processing of plasma interferometer signals.** Cummins, W.F. (Univ. of California, Livermore). *J. Comput. Phys.*; **18**: No. 1, 106-113(May 1975).

A set of FORTRAN IV routines are given that retrieves digitized signals from the data system magnetic tape and performs an analysis of interferometric signals. The use of this data analysis system has increased the overall sensitivity of the interferometer to the low 10^{10} cm^{-3} range. (MOW)

PLASMA KINETICS - GENERAL

4250 (COO—2218-40) **Comments about proposed D-He³ experiments in the TFTR.** Hively, L.M.; Miley, G.H. (Illinois Univ., Urbana (USA)). 6 Oct 1975. Contract AT(11-1)-2218. 25p. Dep. NTIS $4.50.

D-He³ experiments to simulate DT burns in TFTR have been proposed by members of the Fusion Studies Center at the University of Illinois. Some basic considerations, involved in planning these experiments, are discussed along with important results to be obtained from such measurements. It is argued that fusion-product orbits, instabilities, and other phenomena can be investigated by D-He³ simulation of DT burns, before the TFTR is contaminated by tritium. This approach will allow changes in experimental design before subsequent DT burn studies. (auth)

4251 (JINR—P13-9132) **Violation of similarity in electrical discharges in gases.** Lozanskii, E.D.; Pontekorvo, D.B. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 8p. (In Russian). Dep. NTIS (US Sales Only) $4.50.

A new relationship for the first Townsend ionization coefficient was derived taking into account associated ionization processes in the gas. Results of calculations of the first ionization coefficient are presented. It turns out to be, that deviations from similarity laws in electrical discharges may be quite significant. This is in qualitative agreement with published experimental data. (auth)

4252 **High- and low-current-density plasma experiments within the MIT Alcator programme.** Ascoli-Bartoli, U. (CNEN, Frascati, Italy); Bosia, G.; Boxman, G. pp 191-203 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

The operation of Alcator at relatively high magnetic fields (up to 60 kG) and with a plasma radius of about 9 cm has led to plasma currents up to 200 kA corresponding to poloidal fields up to 4.4 kG and average current densities near 750 A/cm^2. Pulses up to 300 ms have been obtained without a feedback system to maintain plasma equilibrium. Neutron production of 10 count/ms has been detected from deuterium plasmas for the entire duration of the best discharges. A relatively large range of plasma densities from 5 x $10^{12}/cm^3$ upward has been reached. Peak electron temperatures up to 1.8 keV have been measured by laser scattering. The constancy of the average density, as of the soft X-ray emission, and the features of neutron emission during long discharges and when switching from deuterium plasmas to hydrogen and vice versa, are indications of a relatively low influx of high-Z impurities. Poloidal field fluctuations with $m = 4, 3, 2$ are detected when q-values lower than 3 are obtained. The initial operation of the Rector device for the investigation of MHD-equilibrium and stability of plasmas with comparable dimension as Alcator but noncircular cross-section has indicated that vertical elongation can be achieved while maintaining the plasma column position by a feedback system. (auth)

PLASMA KINETICS - EXPERIMENTAL

4253 (LA-UR—75-1513) **Ion temperature measurements on the ZT-1 reversed field pinch.** Howell, R.B.; Karr, H. J.; Forman, P.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—1). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Ion temperatures were measured for the Los Alamos toroidal Z Pinch for several different modes of operation. They show an increase with toroidal current and toroidal current rate of rise. They are highest for low forward bias fields. In the next stage of the program, the ZT-S device with a larger tube bore will be used to determine the effect of scaling the pinch minor radius upon T/sub i/ and T/sub e/. (auth)

4254 (UCID—16944) **Spectral measurements of electrons and x rays emitted from plasmas produced using a 1.06-μm laser.** Tirsell, K.G.; Kornblum, H.N.; Catron, H.C.; Slivinsky, V.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Oct 1975. Contract W-7405-Eng-48. 13p. Dep. NTIS $4.50.

Absolute spectral measurements were made of electrons escaping from plasmas produced by focusing 5—10 J, 50—100 ps, 1.06 μm laser pulses on 10-μm-thick Parylene disk targets. Nine spectral bands with 3 to 7.5 keV resolution were obtained from 30 to 190 keV with a 90°-focusing permanent-magnet spectrometer and appropriately positioned silicon electron detectors. The x-ray spectra were measured simultaneously with the electron spectra by means of a K-edge filter technique. Elemental filters were chosen to provide nine spectral cuts from 1.5 to 88 keV. Silicon p-i-n diodes were used for the 1.5 to 17 keV portion of the spectrum and scintillator photomultiplier combinations for higher photon energies, with the 17-keV channel duplicated. Each channel had about 20 percent energy resolution, and the final spectra were unfolded by an iterative technique. (MOW)

PLASMA KINETICS - THEORETICAL

4255 (MATT—1093) **Theory of plasma simulation using the multipole-expansion scheme.** Chen, L.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1975. Contract AT(11-1)-3073. 28p. Dep. NTIS $4.50.

Nonphysical grid effects in plasma simulation using the Multipole-Expansion scheme and Gaussian-shape charge particles are studied analytically in one dimension. General expressions for the linear dispersion relation, fluctuation spectra, energy, and momentum conservations are derived and then compared with those of the Cloud-in-Cell (CIC) scheme. The results indicate that the Dipole-Expansion scheme and its subtracted version have, in general, grid effects comparable to CIC. Grid effects are, however, greatly reduced in schemes keeping higher order moments, such as the Quadrupole-Expansion scheme. (auth)

4256 (MATT—1143) **Orthogonal conductivity of a toroidal plasma.** Boozer, A.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Sep 1975. Contract E(11-1)-3073. 26p. Dep. NTIS $4.00.

The orthogonal conductivity of a toroidal plasma is calculated in the fluid regime. If the damping time for toroidally directed angular momentum is tau/sub N/, the orthogonal conductivity is shown to be sigma/sub perpendicular to/ = (rhoc²/ B²/sub p/)/tau/sub n/ for large tau/sub N/. Here rho is the mass density, c the speed of light and B/sub p/ the poloidal component of the magnetic field. For large tau/sub N/, the flow induced by the orthogonal electric field is almost purely toroidal and of magnitude. c (E/sub r/ — E°/sub r/)/B/sub p/ where E°/sub r/ is the electric field required for ambipolar diffusion. (auth)

4257 (ORNL-TM—5153) **Multi-fluid tokamak transport models.** Hogan, J.T. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 60p. Dep. NTIS $5.45.

The following topics are discussed: (1) development of one-dimensional transport codes, (2) description of tokamaks, (3) survey of codes, (4) commonly used moment equations, (5) relevant physical processes, (6) transport by collisional diffusion and turbulence, (7) methods used to solve the diffusion problem, (8) trapping and thermalization, (9) numerical treatment, (10) models for neutral gas, and (11) numerical solution. (MOW)

4258 (UCID—16947) **Bounce-averaged kinetic equations.** Rensink, M.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Oct 1975. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.00.

The purpose of this report is to summarize the equations and definitions which enter into the bounce-average kinetic description of a mirror-confined plasma. The effects of time- and space-dependent ambipolar potentials and magnetic fields, as well

as anisotropic Rosenbluth potentials are considered. The final result is a bounce-averaged kinetic equation which is written in "conservation form". Boundary conditions and a "normal mode" equation are also given here. (auth)

4259 (UCRL—51820) **SIMPLEX, a code for the solution of linear programming problems.** Walker, H.; Hall, L.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jun 1975. Contract W-7405-Eng-48. 55p. Dep. NTIS $5.45.

A set of procedures is described for solution of a general linear programming problem that seeks to maximize the linear functional W =/sup n/Σ/sub j = 1/ c/sub j/x/ sub j/ for coordinates x/sub j/ greater than or equal to 0, subject to m restrictions of the form/sup n/Σ/sub j = 1/ a/sub ij/x/sub j/ less than or equal to b/sub i/ and l restrictions of the form/sup n/Σ/sub j = 1/ a/sub ij/x/sub j/ = b/sub i/. An LRLTRAN computer code, which performs the maximization, has been developed to follow these procedures and is also described. Illustration of the use of the simplex procedure is given. (auth)

4260 Anomalous plasma resistivity due to ion-acoustic turbulence. Orens, J.H. Princeton, NJ; Princeton, Univ. (1974). 141p. University Microfilms Order No. 75-6665.

Thesis (Ph. D.).

A multidimensional computer simulation study was made of the ion-acoustic instability (the relative electron-ion drift velocity is less than the electron thermal velocity) in the presence of collinear constant electric and magnetic fields, and to investigate the anomalous d.c. resistivity due to its turbulence as a function of both these external fields. The constant electric field is in a regime greater than the Dreicer critical limit, but much less than a field which would accelerate an average electron to its thermal velocity in less than an ion plasma time. The constant magnetic field varies from zero to one for which the electron cyclotron frequency is approximately equal to the electron plasma frequency. Our analysis includes an investigation of the self consistent electric field fluctuations and the ion density turbulence, and we follow the evolution of the particle velocity distribution functions and phase spaces. A discussion is given of the electron and ion heating rates and the stabilization of the current. A detailed analysis is given of the simulation code and especially its level of classical resistivity is discussed. From this basic understanding one is able to determine the degree of resistivity enhancement. Finally the observations are compared to applicable nonlinear theoretical, simulation, and experimental analyses of the ion-acoustic instability and its turbulent resistivity. (Diss. Abstr. Int., B)

4261 Anomalous transport processes in high-temperature toroidal plasmas. Coppi, B.; Pozzoli, R.; Rewoldt, G.; Schep, T. (Massachusetts Inst. of Tech., Cambridge). Contract AT(11-1)-3070. pp 549-559 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Significant transport processes resulting from the excitation of relatively small levels of fluctuations in confined plasmas are investigated in regimes where a fraction of the electron and/or ion population is trapped. When longitudinal electric fields of the order of the runaway field are applied, the trapped electron distribution remains locked in with the magnetic field, while the circulating electron distribution tends to run away from it and produces a distortion in the overall distribution. In particular, when a second peak is formed, low-frequency standing modes are shown to "resonate" with different portions of the distribution, and provide the momentum exchange between circulating and trapped electrons that is needed to produce an effective electrical resistivity. A depletion of impurity ions from the center of a plasma column is shown to be produced by impurity driven modes when a significant temperature gradient of the main ion population is present. This favorable effect is accompanied by ion thermal conductivity, across the magnetic field, enhanced over its collisional value. Particle and electron energy transport are produced by a new, "ubiquitous", mode that does not require a fraction of the ion population to be trapped, exists with or without a significant electron collision rate, and is driven by the electron temperature gradient or by the unfavorable magnetic curvature drift of the ions and trapped electrons, for proper values of the transverse wavelength. Finally, a spatially inhomogeneous hot ion population, resulting from the injection of a beam of fast neutrals for the purposes of ion heating or tritium burning, is shown to induce collective modes which may enhance the rate of energy loss to the main ion population and induce particle transport across the magnetic field of the base plasma. (auth)

4262 Effects of impurities and magnetic divertors on high-temperature tokamaks. Meade, D.M. (Princeton Univ., NJ); Furth, H.P.; Rutherford, P.H.; Seidl, F.G.P.; Duechs, D.F. pp 605-621 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

A one-dimensional tokamak plasma transport code was adapted to include impurity influx, stripping, radiation, and diffusion, as well as the usual processes of hydrogen plasma and heat transport, recycling at the boundary, and multi-generation charge-exchange. Neutral-beam heating, adiabatic compression, and divertor boundary conditions are included as optional features. Illustrative computations are given for present-day and next-generation tokamaks. The problems of impurity control are discussed, and two technical approaches are examined in greater detail: the transient cold-plasma shield, and the poloidal divertor. (auth)

4263 Transport and divertor studies in the FM-1 Spherator. Ando, K.; Ejima, S.; Davis, S. (Princeton Univ., NJ). Contract AT(11-1)-3073. pp 103-114 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Fundamental problems of toroidal fusion devices were investigated in the FM-1 Spherator. These subjects include the transport due to drift-wave turbulence in the trapped-electron regime, poloidal divertor and impurities, and lower hybrid heating. (auth)

4264 Three-dimensional tokamak equilibria. Grad, H. (New York Univ.). pp 153-161 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Conventional tokamaks are low-β and approximately axially symmetric devices. It is therefore appropriate to expand in β about a simple toroidal closed-line vacuum field (B_0 approximately 1/r). To first order there is a force-free field (discharge parallel to B_0); only to second order does it support plasma. In other words,it requires a relatively large current, J approximately β/sup 1/2/, to maintain the plasma in equilibrium. In a bumpy torus, on the other hand, it requires only a current $J \sim \beta$ to confine the plasma. The latter theory is also characterized by the fact that constant pressure contours approximate vacuum contours of constant q_0 equal= $\int dl/B_0$. This is in contrast to the tokamak, where vacuum contours of q_0 are not confined. A theory of low-β, tokamak-like equilibria is described which depart from an arbitrary closed-line vacuum field instead of the usual axially symmetric toroidal field. These equilibria span the range from linear (J approximately β/sup 1/2;bumpy torus scaling to quadratic (J approximately β/sup 1/2;bumpy tokamak scaling. These analytical formulations are appropriate for numerical calculation. (auth)

4265 Theory and numerical simulation of collective transport of plasma in magnetic fields. Canosa, J. (Princeton Univ., NJ); Krommes, J.; Oberman, C.; Okuda, H.; Tsang, K.; Dawson, J.M.; Kamimura, T. pp 177-189 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Numerical and theoretical studies were made on the transport of particles and heat in collisionless plasmas in magnetic fields for both quiescent and turbulent states. The following problems were investigated: (1) A systematic kinetic theory of hydrodynamic fluctuations in a strong magnetic field has been developed to study the particle diffusion due to thermal convective cells. (2) Effects of the density and temperature gradients on thermal convective cells; they are found to destabilize both the ion flute and the convective cells. (3) Effects of the mirroring magnetic field on convective diffusion; they are found to increase the diffusion significantly even for open field lines of force. (4) Turbulent electron heat transfer due to short-wavelength ion fluctuations near the lower hybrid frequency; this may be important in a collisionless plasma. (5) Heat transfer due to emission and absorption of electrostatic plasma waves are studied theoretically and by simulation; agreement has been found for a strong magnetic field case. (6) Particle diffusion in a toroidal magnetic field due to collisions (neo-classical diffusion) and due to collective effects is studied by numerical simulations. Neoclassical theory agrees well with the numerical results when the long-wavelength collective modes are suppressed. (auth)

4266 Conservation form in computational magnetohydrodynamics. Lindemuth, I.R. (Univ. of California, Livermore). *J. Comput. Phys.*; **18**: No. 2, 119-131(Jun 1975).

The question of whether or not to use a conservation form of the internal energy equation in computational magnetohydrodynamics is considered. Conservation errors resulting from both spatial and temporal difference methods are demonstrated, and means of eliminating the spatial errors and reducing the temporal ones are discussed. It is shown that only in the limit Δt yields 0 can a nonconservation form of the internal energy equation be used without destroying in the finite difference equations any of the conservation properties of the magnetohydrodynamic partial differential equations. (auth)

4267 Charge-exchange spectra near the injection energy in tokamaks equipped with tangential neutral beams. Goldston, R.J. (Princeton Univ., NJ). *Nucl. Fusion;* **15**: No. 4, 651-655(Aug 1975).

A relatively simple theory is developed to predict the energy spectrum of charge-exchange neutrals emitted from a tokamak at energies near that of a tangentially injecting neutral beam. The theory is based on a solution to the Fokker—Planck equation which is valid near the injection energy and angle. It is compared with detailed charge-exchange measurements of ion bunches slowing down in the ATC plasma, with steady-state spectrum measurements, and with rise-time measurements of the spectrum near the injection energy after the beam is turned on. Each of these is a test of the classical nature of the slowing-down process, and each gives excellent agreement with theory. On the basis of these results, the theory is used to show how a collimated neutral-beam probe combined with a multi-sight-line detector can be used to measure radial profiles of background neutral density, and of Z/ sub eff/. (auth)

PLASMA PRODUCTION

4268 Electrostatically driven overdense rf plasma source. Motley, R.W.; Bernabei, S.; Hooke, W.M.; Jassby, D.L. (Plasma Physics Laboratory, Princeton University, Princeton, New Jersey 08540). *J. Appl. Phys.*; **46**: No. 8, 3286-3292(Aug 1975).

We describe a radio-frequency plasma generator consisting of two collinear cylinders surrounding a magnetically confined plasma column, excited by up to 7 kW of power at 155 MHz. The source is capable of generating plasma densities of the order of m/subi//m/sube/ times the critical density n/subc/=m/sube/$\omega^2/4\pi e^2$. The plasma density, the efficiencies of plasma heating, and the ion and electron heating associated with this generator are described in detail.

PLASMA INSTABILITIES

4269 (COO—3497-13) **Annual progress report.** Simon, A. (Rochester Univ., N.Y. (USA)). 19 Sep 1975. Contract E(11-1)-3497. 13p. Dep. NTIS $4.50.

Considerable success has been achieved this year in research aimed at extending the asymptotic threshold nonlinear theory to plasmas governed by the Vlasov equation and in a group of linear studies concerned with drift instabilities in sheared magnetic fields. The nonlinear results are general and have been applied to the bump-on-tail instability and to the collisionless drift and the dissipative trapped electron instability in unsheared fields. The linear studies have dealt with the effects of resonant electrons, finite collisionality, finite-beta, neoclassical modifications and ion gyro-motion on trapped electron instabilities in sheared magnetic fields. (auth)

4270 (LA-UR—75-1506) **Numerical simulation of the lower hybrid drift instability.** Hewett, D.W.; Winske, D. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—3). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Particle simulations of strongly inhomogeneous plasma phenomena that model theta-pinch behavior in the implosion and post-implosion phases were performed using an inhomogeneous, self-consistent Vlasov equilibrium as an initial state. In the hot ion regime a strong flute instability was observed, whose properties agree well with those predicted by the linear and nonlinear theory of the lower-hybrid-drift instability. (auth)

4271 (LA-UR—75-1541) **Scyllac feedback stabilization experiments.** Cantrell, E.L.; Ellis, W.R.; Freeman, B.L.; Gribble, R.F.; Gutscher, W.D.; Johnson, K.J.; Kutac, K.F.; Miller, G.; Quinn, W.E. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—7). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

For feedback stabilization experiments the magnetic field in a 120° sector of the Scyllac torus has been lowered to 17 kG, and the plasma parameters adjusted accordingly to reduce the m = 1 instability growth rates to values which are compatible with the response time of the feedback system. Initial plasma studies have been completed and compared with MHD sharp-boundary theory. Studies of the effectiveness of l = 0 and l = 2 feedback fields are reported. Modifications of the Scyllac feedback stabilization system have resulted in improved reliability, decreased response times, and increased output currents. (auth)

4272 (LA-UR—75-1558) **Dynamic model of gross plasma motion in Scyllac.** Miller, G. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944—20). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Plasma confinement in a high-beta stellarator such as Scyllac is ended by an unstable long wavelength m = 1 motion of the plasma to the discharge tube wall. Such behavior has been observed in several experiments and is considered well understood theoretically on the basis of the sharp boundary ideal MHD model. However the standard theoretical approach using the energy principle offers little physical insight, and sheds no light on the process by which the plasma reaches an equilibrium configuration starting from the initial conditions created by the theta pinch implosion. It was the purpose of this work to find a more complete explanation of the observed plasma behavior in Scyllac and to apply this to the design of a feedback stabilized experiment. Some general consideration is also given to dynamic stabilization. (auth)

4273 (LA-UR—75-1568) **Numerical studies of the linear theta pinch.** Brackbill, J.U.; Menzel, M.T.; Barnes, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—11). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

Aspects of several physical problems associated with linear theta pinches were studied using recently developed numerical methods for the solution of the nonlinear equations for time-dependent magnetohydrodynamic flow in two- and three-dimensions. The problems studied include the propagation of end-loss produced rarefaction waves, the flow produced in a proposed injection experiment geometry, and the linear growth and nonlinear saturation of instabilities in rotating plasmas, all in linear geometries. The studies illustrate how numerical computations aid in flow visualization, and how the small amplitude behavior and nonlinear fate of plasmas in unstable equilibria can be connected through the numerical solution of the dynamical equations. (auth)

4274 (LA-UR—75-1577) **Time-dependent calculations of equilibrium and stability problems in Scyllac and Tokamak geometries.** Brackbill, J.U.; Barnes, D.C. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—12). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

In preparation for a study of the equilibrium and stability properties of Scyllac, a sequence of problems has been studied by numerically solving the MHD equations in three dimensions. Among these are computations of the dynamics of nonequilibrium plasmas in toroidal theta pinches and high beta tokamaks, which illustrate what happens when there is no equilibrium as well as the approach to equilibrium when one exists. The evolution of Kruskal—Shafranov modes in a diffuse screw pinch was also computed from small amplitude to its final nonlinear state. The application of the same method to Scyllac is shown. (auth)

4275 (MATT—1095) **Study of magnetohydrodynamic modes in tokamak configurations with noncircular cross sections.** Chance, M.S.; Dewar, R.L.; Glasser, A.H.; Greene, J.M.; Grimm, R.C.; Jardin, S.C.; Johnson, J.L.; Rosen, B.; Sheffield, G.V.; Weimer, K.E. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jan 1974. Contract AT(11-1)-3073. 14p. (IAEA-CN—33/A12-4). Dep. NTIS $4.00.

Stability criteria for localized instabilities for both ideal and resistive models are derived and evaluated for general axisymmetric configurations. A numerical scheme for determining the spectrum in these configurations is developed. Application is made to the special case of an elliptical cylindrical plasma column, with finite pressure and length, carrying a uniform axial current. (auth)

4276 (MATT—1096) **Nonlinear saturation of the trapped-ion mode.** LaQuey, R.E.; Mahajan, S.M.; Rutherford, P.H.; Tang, W.M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

A nonlinear model of the collisional trapped-ion mode in tokamak geometry is presented, in which the energy in long wavelength instabilities is transferred to short wavelength modes which are then damped by ion bounce resonances. Near marginal stability, the saturation of a single unstable Fourier mode is computed. Far from marginal stability, steady state nonlinear solitary waves containing many Fourier modes are found. Particle transport is computed in both cases. (auth)

4277 (MATT—1097) **Defeat of shear stabilization by peaking of the diamagnetic frequency profile.** Sauthoff, N.R.; Okabayashi, M.; Schmidt, J.A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Dec 1974. Contract AT(11-1)-3073. 7p. Dep. NTIS $4.00.

The radial wave equation describing collisionless drift instabilities in plasma is solved including the effects of a peaked diamagnetic frequency profile. Radially localized fluctuations with no radial energy propagation are found in cases with sufficiently low shear and large peaking. (auth)

4278 (MATT—1162) **Oscillating two stream instability at the resonance of obliquely incident radiation in inhomogeneous plasmas.** Kuo, Y.Y.; Oberman, C.; Liu, C.S.; Troyon, F. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 26p. Dep. NTIS $4.00.

The growth rate and the threshold value were calculated for the oscillating two-stream instability for an electromagnetic wave obliquely incident on an inhomogeneous plasma. The localization of the instability is found to be in the overdense region near the threshold and to shift toward the local plasma resonance when the pump intensity increases. (auth)

4279 (MATT—1163) **Resistive instabilities in a tokamak.** Glasser, A.H.; Greene, J.M.; Johnson, J.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 30p. Dep. NTIS $5.00.

Application of resistive instability theory shows that toroidal effects can stabilize the tearing mode in devices like the Princeton Large Torus. Contraction of the current channel is destabilizing. Finite fluid compressibility is crucial to this phenomenon. (auth)

4280 (ORNL-TM—5158) **Resonant electron effects on trapped electron instabilities.** Catto, P.J.; Tsang, K.T.; Callen, J.D.; Tang, W.M. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 14p. Dep. NTIS $4.00.

The importance of retaining resonant electron contributions when considering trapped electron instabilities has recently been noted. The necessity of distinguishing between perpendicular and parallel components in electron velocity space, rather than simply considering energy, is pointed out and employed to estimate the effects of finite collisionality. For much of the banana regime the dominant resonant electron contributions are shown to be due to circulating electrons with parallel velocities in the vicinity of and slightly below the electron thermal speed. (auth)

4281 (ORNL-tr—4029) **Calculation results on dynamics of helical MHD: instability.** Gerlach, N.I.; Zueva, N.M. 1973. Translation of preprint No. 91. 9p. Dep. NTIS $4.50.

Dynamics of helical MHD-instability is numerically investigated. A simplified equilibrium cylindrical configuration is chosen, and a small resonance helical initial perturbation is given: the constant pitch value of helical magnetic field lines is the same one as for the initial perturbation. The arising motion is supposed to conserve helical symmetry. An appropriate initial-value problem is solved by means of computer. Patterns of density distribution obtained at different time moments indicate the process of the instability development to be quasi-periodical. At initial stage of the process, vacuum bubbles are coming into the plasma. Further the surfaces of constant density form a fibrous structure. (auth)

4282 **Stabilizing mechanisms for loss-cone modes.** Baldwin, D.E. (Univ. of California, Livermore); Berk, H.L.; Pearlstein, L.D.; Kammash, T.; Uckan, T. pp 301-310 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

An investigation was made of various mechanisms that might be responsible for the apparent absence of the theoretically predicted drift-cyclotron-loss-cone mode in high-density mirror machines when ω^2/sub pe/ approximately ω^2/sub ce/. Warm plasma outside the trap at 2XII parameters is found to affect the mode only weakly. Fanning of the magnetic field is found to stabilize modes sharply resonant in k/sub perpendicular to/, such as the Dory—Guest—Harris mode, but not to affect instabilities with broad spectra. Also investigated is the possibility of electron orbit diffusion due to the presence of a suggested high-frequency electron instability. Stabilization by this means would explain a number of experimentally observed properties; however, the nonlinear picture is incomplete as discussed. The standard one-dimensional, absolute instability criterion is extended to two dimensions and effects of finite m/sub e//m/sub i/ less than β much less than 1 are included. At ion energies spanning present experimental conditions to reactor conditions, one finds only a weak shift in the instability threshold densities. (auth)

4283 **Plasma containment in 2XII.** Coensgen, F.H.; Cummins, W.F.; Molvik, A.W.; Nexsen, W.E. Jr.; Simonen, T.C.; Stallard, B.W. (Univ. of California, Livermore). pp 323-328 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Experiments in the 2XII magnetic mirror device have achieved high-beta (β approximately 0.3 to 0.5) plasma confinement. Near classical confinement was observed in the range 2 to 5 x 10^{13} cm^{-3} with average ion energies of 1 to 3 keV. The measured electron energy, 50 to 150 eV, was consistent with classical energy transfer from the hot ions. At lower plasma densities, the loss rate departs from classical confinement owing to quasi-classical scattering and ion cyclotron fluctuations. The injection of a 10-A, 20-keV neutral atom beam produced no beam-driven instabilities, nor did it increase charge-exchange losses. (auth)

4284 **Study of magnetohydrodynamic modes in tokamak configurations with noncircular cross-sections.** Chance, M.S.; Dewar, R.L.; Glasser, A.H. (Princeton Univ., NJ). Contract AT(11-1)-3073. pp 463-473 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

Stability criteria for localized instabilities for both ideal and resistive models are derived and evaluated for general axisymmetric configurations. A numerical scheme for determining the spectrum in these configurations is developed. Application is made to the special case of an elliptical cylindrical plasma column, with finite pressure and length, carrying a uniform axial current. (auth)

4285 **Numerical studies of nonlinear evolution of kink and tearing modes in tokamaks.** White, R. (Inst. for Advanced Study, Princeton, NJ); Monticello, D.; Rosenbluth, M.N.; Strauss, H.; Kadomtsev, B.B. Contract AT(11-1)-3237; AT(11-1)-3073. pp 495-503 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

A set of numerical techniques for investigating the full nonlinear unstable behavior of low-β kink modes of given helical symmetry in tokamaks is presented. Uniform current density plasmas display complicated deformations including the formation of large vacuum bubbles, provided that the safety factor q is sufficiently close to integral. Fairly large m = 1 deformations, but not bubble formation, persist for a plasma with a parabolic current density profile (and hence shear). Deformations for m greater than or equal to 2 are however greatly suppressed. (auth)

4286 **Stability of kink modes in high-beta tokamaks.** Freidberg, J.P.; Goedbloed, J.P.; Grossmann, W.; Haas, F.A. (Los Alamos Scientific Lab., NM). pp 505-514 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

MHD stability calculations of high-β approximately a/R tokamak configurations are given for three separate classes of equilibria: (1) the thin-skin sharp-boundary model, (2) the quasi-uniform-current model, and (3) the diffuse-profile model. (auth)

4287 **Stability theory of dissipative trapped-electron and trapped-ion modes.** Horton, W. Jr. (Univ. of Texas, Austin); Ross, D.W.; Tang, W.M. Contract AT(11-1)-3073; AT(40-1)-4478. pp 541-548 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. 1. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.1); CONF-741105—P1.

This paper treats topics in the linear theory of dissipative trapped-electron instabilities, and in the nonlinear theory of the dissipative trappedpion instabilities. Stability criteria are obtained for dissipative trapped-electron modes in a tokamak-type magnetic field with shear. In the important case where the mode is driven by the electron temperature gradient, and neglecting "ballooning" effects, shear is found to stabilize the mode if typically r/sub n//L/sub s/ greater than 0.1 (r/2R)/sup 1/2/ dln T/sub e//dln n, a condition that can be attained. With weak shear, it is shown, however, that the mode-structure along the field can exhibit substantial "ballooning"shear-stabilized, is considered in its nonlinear regime. Including nonlinear E x B motions, exact stationary trapped-ion-mode solitary-wave solutions are found, in which the wave energy in longer azimuthal wavelengths passes to shorter-wavelength components that are strongly damped by ion bounce resonances; the amplitudes are sufficiently reduced that a diffusion lower than Kadomtsev's is indicated. As a second nonlinear mechanism, anomalous velocity-space scattering due to the development of an unstable loss-cone-type ion distribution function is considered; this mechanism raises the effective ion collision frequency and increases the stability of the longer-azimuthal-wavelength modes. (auth)

4288 Parametric instabilities in inhomogeneous, spherical plasmas. Liu, C.S.; Rosenbluth, M.N.; White, R.B. (Inst. for Advanced Study, Princeton, NJ). pp 515-524 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Temporally growing instabilities for Raman and Brillouin sidescattering are found to persist in an inhomogeneous, expanding spherical plasma with nonuniform expansion velocity. Their growth rates and thresholds are modified by the spherical geometry because of the wave refraction. (auth)

4289 High-density fusion and Z-pinch. Hartman, C.W.; Cheng, D.Y.; Cooper, G.E.; Eddleman, J.L.; Munger, R.H. (Univ. of California, Livermore). pp 653-661 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

The formation of a Z-pinch in dense gas is investigated using numerical modeling in one and two dimensions. Hot, dense Z- pinches are calculated with n approximately 2 x 10^{21} cm^3 and T equals 10 keV. Relaxation by sausage instability of an unstable pinch profile to a marginally stable one is calculated along with end losses in 2 dimensions to show that, if plasma is confined for N = 50 to 200 sound transits across the radius a, pinches with length L = Na are of interest for fusion power. A conceptual, "no-wall" fusion reactor is discussed. (auth)

4290 Numerical study of the magnetohydrodynamic spectra in Tokamaks using Galerkin's method. Dewar, R.L.; Greene, J.M.; Grimm, R.C.; Johnson, J.L. (Princeton Univ., NJ). *J. Comput. Phys.;* **18**: No. 2, 132-153(Jun 1975).

A computational technique is described for determining the ideal magnetohydrodynamic spectrum and its associated eigenfunctions. The method is suitable for axisymmetric toroidally confined plasmas with arbitrary cross sections. Using the special case of a long, straight, elliptical plasma column with low pressure and uniform axial current where analytic results are available, a study is made of the efficacy of two different choices of expansion functions. The use of a finite-element representation, keeping only a small number of terms, is shown to provide a good description of the system. (auth)

4291 Improved calculation of critical magnetic shear in an inhomogeneous plasma. Rosenbluth, M.N. (Inst. for Advanced Study, Princeton, NJ); Catto, P.J. *Nucl. Fusion;* **15**: No. 4, 573-582(Aug 1975).

Previous calculations of the amount of magnetic shear necessary to stabilize a drift wave in an inhomogeneous plasma with a linear density profile have been somewhat inconsistent in that the destabilizing influence of the resonant electrons is treated as a perturbation. By removing this inconsistency and, in fact, by including all non-resonant electron effects as well, an improved stability criterion is found analytically to agree with the previous perturbation technique result to within a multiplicative factor very nearly equal to one for 1 greater than or equal to L/sub n//L/sub s/ much greater than m/M, where L/sub n/ and L/sub s/ are the density and shear lengths and m and M are the electron and ion masses. Both the previous and the present treatments require ln (ML/sub n//mL/sub s/) greater than 1, and the stability condition is found herein to be relaxed by approximately [ln[ln(ML/sub n//mL/sub s/)]]/sup 1/3/. Furthermore, the critical shear is shown to be relatively insensitive to the non-resonant electron corrections not retained in previous work. Consequently, when finite-β effects are included, both the neglect of non-resonant electron corrections to the fluid response and the treatment of the resonant electrons via perturbation theory are well motivated. (auth)

4292 Self-consistent plasma and engineering parameters for self-sustaining (ignited) tokamak power reactors. Stacey, W.M. Jr. (Argonne National Lab., IL). *Nucl. Fusion;* **15**: No. 4, 583-593(Aug 1975).

Self-consistent calculations of the plasma energy and particle balances, the plasma current required for confinement according to trapped-ion instability theory, the toroidal magnetic field required for MHD-stability, the transformer magnetic field required to create and maintain the plasma current, and the maximum power allowed by either MHD-stability or neutron power flux to the first-wall limits are reported. If q approximately 1 and β/ sub THETA/ approximately $\sqrt{}$ A can be achieved and if plasma contamination can be held to Z/sub eff/ approximately 1.3, then reactors with a wide range of geometries (R = 7.5 - 15.0 m, A = 3-5) with power outputs of 1-10 GW and burn times of the order of hours are feasible with realistic technological constrants—maximum toroidal fields at the coils less than 80 kG and maximum neutron power fluxes on the first wall less than 2.0 MW/m^2. The consequences of operation under different plasma MHD-stability and technological constraints are also examined. (auth)

4293 Stability of a closed-line Scyllac configuration. Freidberg, J.P.; Gerwin, R.A. (Los Alamos Scientific Lab., NM). *Nucl. Fusion;* **15**: No. 4, 605-610(Aug 1975).

A stability analysis against m = 1 modes is presented for a closed-line Scyllac configuration. The configuration consists basically of a large THETA-pinch field and moderate-size l = +1 and l = -1 fields with exactly equal amplitudes. It was originally hoped that the l = +-1 system would have more favorable stability properties than the pure l = 1 Scyllac configuration. The calculations show that this is not the case, and that, indeed, the l = +-1 system is far more unstable. (auth)

4294 Frequency-dependent feedback control of plasma instabilities. Uckan, N.A.; Kammash, T. (Univ. of Michigan, Ann Arbor). *Nucl. Fusion;* **15**: No. 4, 611-619(Aug 1975).

A general theory of simultaneous feedback stabilization of multimode oscillations in collisionless magnetized plasma is developed for reactive and dissipative instabilities. The gain and phase requirements of the feedback circuit are obtained using familiar stabilization techniques. From causality and stability considerations further requirements on phase and gain are determined for a physically realizable feedback system. It is shown that unstable modes can be suppressed without driving new instabilities or causing stable modes to become unstable. Although this method of stabilization provides marginal stability for instabilities of the reactive type by correctly choosing the frequency dependence of the feedback gain, this problem can be overcome, and the stability properties of the feedback loop can be improved. Applications to some known reactive instabilities are included as examples. (auth)

4295 Continuous MHD spectrum in toroidal geometries. Pao, Y.P. (New York Univ., NY). *Nucl. Fusion;* **15**: No. 4, 631-635(Aug 1975).

The continuous spectrum for tokamak geometries is shown to be given by a reduced (one-dimensional nonsingular) eigenvalue problem on the resonant surface. Properties of this reduced eigenvalue problem and singularity of the eigenfunctions for the continuous spectrum near the resonant surface are obtained. (auth)

4296 Influence of self-fields on the filamentation instability in relativistic beam-plasma systems. Davidson, R.C.; Hui, B.H.; Kapetanakos, C.A. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Fluids;* **18**: No. 8, 1040-1044(Aug 1975).

The influence of equilibrium self-fields on the filamentation instability in relativistic beam-plasma systems is investigated within the framework of a macroscopic cold-fluid description. For a low-density beam (n/subb/very-much-less-than/subc/) propagating through a nonrelativistic plasma background, the instability criterion for ordinary-mode propagation perpendicular to B^0/subz/e/subz/ is shown to be (assuming perturbations with partial/partialθ=0partial/partialz) (ω^2/subp//subb/β^2/subb//subz//ω^2/subc//subb/) {1+(2ω^2/subp//subb//ω^2/subc//subb/)β^2/subb//subz/(1-f/subM/)-(1-f/subq/)closing-brace^{-1}>1, where ω/subp//subb/ is the beam plasma frequency, ω/subc//subb/ is the beam cyclotron frequency, β/subb//subz/c is the axial velocity of

the beam, and f/subM/ and f/subq/ are the fractional current neutralization and fractional charge neutralization, respectively, by the background plasma. The azimuthal self-magnetic field has a stabilizing influence for f/subM/<1, whereas the radial self-electric field has a destabilizing influence for f/subq/<1.

4297 Electromagnetic ion cyclotron instability driven by ion energy anisotropy in high-beta plasmas. Davidson, R.C.; Ogden, J.M. (Los Alamos Scientific Laboratory, University of California, Los Alamos, New Mexico 87544). *Phys. Fluids;* **18**: No. 8, 1045-1050(Aug 1975).

Low frequency ($\omega \cong \omega$/subc//subi/=c/subi/B_0/m/subi/c) transverse electromagnetic perturbations propagating parallel to a confining magnetic field B_0c/subz/ are shown to exhibit instability in the presence of ion energy anisotropy with T/subi//sub perpendicular/>T/subi//sub parallel/. The characteristic maximum growth rate for T/subi//sub perpendicular/very-much-greater-thanT/subi//sub parallel/ is γ/subM/$\cong (\beta$/subi//sub perpendicular//2)$^{1/2}\omega$/subc//subi/, where β/subi//sub perpendicular/=8πn/subi/T/subi//sub perpendicular//B^2_0, and the wavelengths corresponding to instability are of order c/ω/subp//subi/, where ω/subp//subi/ is the ion plasma frequency. Within the context of a quasi-linear model, it is shown that the characteristic time scale for energy isotropization through nonlinear response of the ions to the instability is several γ^{-1}/subM/. Since γ^{-1}/subM/very-much-less-thantau/subi//subi/ (the ion-ion binary collision time) in typical high-density pinch experiments, this instablity appears to provide a viable collective mechanism for ion energy isotropization during the implosion or post-implosion phases of these experiments. It is also shown that the instability persists in the limit of weakly magnetized ions (vertical-barω+iyvertical-barvery-much-greater-thanvertical-barω/subc//subi/vertical-bar, k^2/subz/r^2/subL/subi/very-much-greater-than1) and strongly magnetized electrons (vertical-barω+iyvertical-barvery-much-less-thanvertical-barω/subc//sube/vertical-bar, k^2/subz/r^2/subL//sube/very-much-less-than1) provided β/subi//sub perpendicular/very-much-greater-than1. The instability also has applications to astrophysical plasmas with T/subi//sub perpendicular/>T/subi//sub parallel/ as well as laboratory plasmas heated by neutral-particle injection perpendicular to B_0.

4298 (UCRL-Trans—10935) **Lagrangian approach to the problem of the hydrodynamic instabilities of a spheical implosion.** Brun, L.; Sitt, B. (CEA Centre d'Etudes de Limeil, 94 - Villeneuve-Saint-Georges (France)). Sep 1975. Translation of French report DO—133. 22p. Dep. NTIS $4.50.

For the study of hydrodynamic instabilities of a spherical implosion, a very simple Lagrangian-type formulation is proposed, based on the introduction of a potential of transverse displacements, and on the decomposition of disturbances into spherical harmonics. The different modes are decoupled, and can be studied independently. The development of a numerical code utilizing this formulation can then be considered. (auth)

PLASMA WAVE PHENOMENA

4299 (COO—3004-11) **Department of Physics annual progress report, June 1975.** Schmidt, G. (Stevens Inst. of Tech., Hoboken, N.J. (USA)). Jun 1975. Contract AT(11-1)-3004. 10p. (SIT—291). Dep. NTIS $4.50.

A dispersion relation was derived for the interaction of a large amplitude Langmuir wave with ion waves in a uniform plasma. The dispersion relation contains in addition to the well known modulational and resonant backscatter instabilities, a modified oscillating two stream instability, a nonlinear Landau instability (resistive quasi mode) and a reactive quasi mode. It was found that envelope solitons are unstable against perpendicular perturbations, and tend to break up into blobs while radiating away energy in the form of electron and ion waves. This is in agreement with recent numerical computations. A new definition of the sign of wave energy is given, which is valid where the old definition based on an expansion procedure breaks down. It is shown that a beam-plasma wave does not produce explosive instabilities. An eigenvalue equation describing the propagation of collisionless electrostatic drift waves in a magnetoplasma, with an arbitrary one dimensional density profile is derived. It is shown that in general several different waveforms exist each with its respective dispersion relation. A numerical analysis was carried out on ion heating by a new parametric process. It was found that as the ion temperature approaches the electron temperature the heating process rapidly saturates. (auth)

4300 (COO—3070-129) **Nonlinear interaction of three wave packets in time and space.** Bers, A.; Reiman, A. (Massachusetts Inst. of Tech., Cambridge (USA)). 1975. 5p. (CONF-750606—9). Dep. NTIS $4.50.

From 7. conference on numerical simulation of plasmas; New York, New York, USA (2 Jun 1975).

The resonant, nonlinear interaction of three coherent waves are described by the coupled nonlinear differential equations for their slowly varying amplitudes. The solutions for these equations are discussed. (MOW)

4301 (MATT—1084) **Energy transport across a magnetic field by plasma waves.** Canosa, J.; Okuda, H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 46p. Dep. NTIS $5.50.

Cross-field energy transport by electrostatic plasma waves was studied theoretically and numerically for a plasma near thermal equilibrium. Energy transfer by plasma waves is significant in a high temperature plasma where collisional transport is quite small. For strong magnetic fields (ω/sub c/ greater than or equal to ω/sub p/), the simulations verify the theoretical prediction that energy transport by plasma waves increases slowly with the magnetic field, and that in the limit of large field magnitudes wave transport dominates classical collisional transport. Furthermore, in a strong magnetic field the relaxation of the temperature by wave transport may result in an anisotropic velocity distribution. For weak fields (ω/sub p/ greater than ω/sub c/), the simulation shows that collisional transport is more important than wave transport, also in agreement with the theory. (auth)

4302 (MATT—1090) **Excitation of lower-hybrid waves by a slow-wave structure.** Bellan, P.; Porkolab, M. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 14p. Dep. NTIS $4.00.

The excitation of lower hybrid waves by a multiple ring slow wave structure (4 waves, lambda = 23 cm) in a magnetized plasma is discussed. Wavelengths measured parallel and perpendicular to the magnetic field were in agreement with the theoretical dispersion relation. The waves propagated in a packet defined by the axial length of the slow wave structure. (auth)

4303 (UCID—16776) **Numerical results from a study of LiH: the proposed standard material for the high pressure shock experiment.** Rogers, F.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 6 May 1975. Contract W-7405-Eng-48. 13p. Dep. NTIS $4.00.

It is proposed to send a high pressure shock wave through a layer of LiH and then into a sample of high Z-material, resulting in a reflected shock wave back into the LiH. If the Hugoniot and some reflected Hugoniots for LiH are known the EOS of the sample can be obtained from the "impedance matching method." The theory and its range of validity are described. (MOW)

4304 (UCRL—51946) **Mode coupling of electron plasma waves.** Harte, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. Contract W-7405-Eng-48. 121p. Dep. NTIS $5.45.

Thesis.

The driven coupled mode equations are derived for a two fluid, unequal temperature (T/sub e/ much greater than T/sub i/) plasma in the one-dimensional, electrostatic model and applied to the coupling of electron plasma waves. It is assumed that the electron to ion mass ratio identical with m/sub e/M/sub i// much less than 1 and eta^2/sub ko/k lambda/sub De/ less than 1 where eta^2/sub ko/ is the pump wave's power normalized to the plasma thermal energy, k the mode wave number and lambda/sub De/ the electron Debye length. Terms up to quadratic in pump power are retained. The equations describe the linear plasma modes oscillating at the wave number k and at ω/sub ek/, the Bohn Gross frequency, and at Ω/sub k/, the ion acoustic frequency, subject to the damping rates ν/sub ek/ and ν/sub ik/ for electrons and ions and their interactions due to intense high frequency waves E/sub k//sup l/. n/sub o/ is the background density, n/sub ik/ the fluctuating ion density, ω/sub pe/ the plasma frequency. (auth)

4305 Hot-electron production, anomalous absorption, and effect of intense electromagnetic fields on inverse bremsstrahlung absorption near the electron plasma frequency. Brownell, J.H.; Dreicer, H.; Ellis, R.F.; Ingraham, J.C. (Los Alamos Scientific Lab., NM). pp 599-608 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Measurements are presented of anomalously large microwave absorption near the electron plasma frequency ω/sub p/ by a completely ionized plasma. The threshold electric field required for the onset of anomalous absorption has been measured over a density range that is large enough to separate clearly the effects of Landau and collisional damping. Good agreement is demonstrated between these measurements and the threshold values predicted by a computer solution of the exact dispersion

relation for AC parametric instabilities. Energy distribution measurements are presented for the hot, non-thermal electron tail produced by such anomalous absorption. The nature of these distributions depends strongly upon (ω/sub p//ω)² and microwave power. In some cases a large fraction of the anomalously absorbed power goes into less than 1 percent of the electrons and a bump develops on the hot tail. Below the threshold for anomalous absorption, the classical electron-ion collision rate, ν/sub ei/, from a measurement of the inverse bremsstrahlung absorption rate has been deduced. The first experimental evidence that intense electromagnetic fields modify ν/sub ei/ is reported. Observations from these experiments yield a simple empirical relation that applies for AC drift speeds as large as eE/(mω) approximately (kT/sub e//m)/sup 1/2/. Ohmic heating is minimized in these experiments by use of very short microwave pulses. (auth)

THERMONUCLEAR POWER PLANTS

4306 (BNWL-SA—5488) **Envelope of current CTR powerplant design characteristics.** Gore, B.F. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. 6p. (CONF-751101—33). Dep. NTIS $4.00.

From Joint meeting of the American Nuclear Society and the Atomic Industrial Forum; San Francisco, California, USA (16 Nov 1975).

An envelope of characteristics of the ten current U. S. design concepts for D—T fueled CTR powerplants is presented. Designs based upon both magnetic and inertial plasma confinement are included. This envelope has been defined for reference in environmental and economic analyses of the effects of extensive generation of electric power by CTR powerplants. (auth)

4307 (CONF-751125—35) **Tokamak experimental power reactor.** Stacey, W.M. Jr.; Maroni, V.A.; Purcell, J.R. (Argonne National Lab., Ill. (USA)). 1975. 7p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A summary is given of a conceptual design study of a Tokamak Experimental Power Reactor (TEPR). Some features of the TEPR are outlined. (MOW)

4308 (LA-UR—75-1502) **Scyllac fusion test reactor design.** Linford, R.K.; Oliphant, T.A.; Thomassen, K.I. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—8). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The SFTR is a proposed 80-m diameter D—T burning toroidal theta pinch. The system is designed to achieve Q = 1 where Q is the ratio of the total thermonuclear energy output to the maximum stored energy in the plasma. SFTR design studies will provide valuable guidance to the Scyllac related research and to the needed technological development. This paper describes the portion of the system directly related to the plasma confinement, stability, and heating, and outlines the approach used to obtain an operating point consistent with Q = 1, m = 1 stability, and technological limitations. (auth)

4309 (LA-UR—75-1565) **High density linear systems for fusion power.** Ellis, W.R.; Krakowski, R.A. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-750944—19). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

The physics and technological limitations and uncertainties associated with the linear theta pinch are discussed in terms of a generalized energy balance, which has as its basis the ratio (Q/sub E/) of total electrical energy generated to net electrical energy consumed. Included in this total is the virtual energy of bred fissile fuel, if a hybrid blanket is used, as well as the actual of real energy deposited in the blanket by the fusion neutron. The advantages and disadvantages of the pulsed operation demanded by the linear theta pinch are also discussed. (MOW)

4310 (MATT—1082) **Princeton Reference Design Fusion Power Plant.** Price, W.G. Jr. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1974. Contract AT(11-1)-3073. 9p. (IAEA-CN—33/G1-4). Dep. NTIS $4.00.

The Princeton Reference Design Fusion Power Plant is an electrical generating station based upon a large Tokamak confining a D-T plasma. The plasma major and minor radii are nominally 10.5 m by 3.2 m; the toroidal field at the center-line is 6 T. With a mean ion temperature of 30 keV, an average β of 0.04, and an average tau of 3.83 s a fusion power of 3440 MW is achieved during 97 minutes of the 100 minute long-pulse cycle. The plasma throughput of 2.8 x 10^{22} ions/s is deflected down a divertor channel where it cools by radiation and is neutralized, exhausting as hot gas to the vacuum pumps. The total thermal power of 5305 MW is carried by a helium coolant to a conventional steam cycle producing 2030 MWe net. Tritium is bred in an 80 cm thick blanket of eutectic flibe (53.1 percent beryllium fluoride and 46.9 percent lithium fluoride) with Nimonic PE-16 (43 percent nickel, 39 percent iron, 18 percent chromium) as the structural material; the blanket-averaged volume fractions are 69.8 percent flibe, 9.4 percent PE-16, and 20.8 percent helium. The breeding ratio of 1.04 will allow doubling of the 2.57 kg inventory in 121 days. The nominal wall load of 1.76 MW of DT neutrons per m implies a total flux of 8.65 x 10^{14} n/m².s at the wall and a corresponding helium production rate of 275 ppm/year. (auth)

4311 (MATT—1155) **Tokamak engineering test reactor.** Conn, R.W.; Jassby, D.L. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Jul 1975. Contract E(11-1)-3073. 36p. Dep. NTIS $5.00.

The design criteria for a tokamak engineering test reactor can be met by operating in the two-component mode with reacting ion beams, together with a new blanket-shield design based on internal neutron spectrum shaping. A conceptual reactor design achieving a neutron wall loading of about 1 MW/m² is presented. The tokamak has a major radius of 3.05 m, the plasma cross-section is noncircular with a 2:1 elongation, and the plasma radius in the midplane is 55 cm. The total wall area is 149 m². The plasma conditions are T/sub e/ approximately T/sub i/ approximately 5 keV, and ntau approximately 8 x 10^{13} cm^{-3}s. The plasma temperature is maintained by injection of 177 MW of 200-keV neutral deuterium beams; the resulting deuterons undergo fusion reactions with the triton-target ions. The D-shaped toroidal field coils are extended out to large major radius (7.0 m), so that the blanket-shield test modules on the outer portion of the torus can be easily removed. The TF coils are superconducting, using a cryogenically stable TiNb design that permits a field at the coil of 80 kG and an axial field of 38 kG. The blanket-shield design for the inner portion of the torus nearest the machine center line utilizes a neutron spectral shifter so that the first structural wall behind the spectral shifter zone can withstand radiation damage for the reactor lifetime. The energy attenuation in this inner blanket is 8 x 10^{-6}. If necessary, a tritium breeding ratio of 0.8 can be achieved using liquid lithium cooling in the outer blanket only. The overall power consumption of the reactor is about 340 MW(e). A neutron wall loading greater than 1 MW/m² can be achieved by increasing the maximum magnetic field or the plasma elongation. (auth)

4312 (MATT—1158) **Princeton Fusion Power Plant superconducting magnet system and costs.** File, J. (Princeton Univ., N.J. (USA). School of Engineering and Applied Science). Oct 1975. Contract E(11-1)-3073. 27p. (CONF-750438—9). Dep. NTIS $4.00.

From 5. international conference on magnet technology; Frascati, Italy (21 Apr 1975).

The Princeton University Reference Design of a proposed fusion power plant has been previously described. This paper describes details of the superconducting magnet system consisting of toroidal field, divertor, ohmic heating, equilibrium field and control field magnets, all of which are wound of Nb_3Sn conductor. The toroidal field coils are of the moment-free, "D" type, previously described. The toroidal field magnet is comprised of 48 discrete "D" coils, 12m x 19m bore. The magnet has a stored energy of 250 x 10^9 joules. The magnet which is operated at a maximum field of 16T is described in detail. Fault conditions are calculated and design conditions based on maximum fault forces are outlined. In addition, the Dewar System, the refrigeration plant (requiring 280 kW of refrigeration), the safety system, and the coil protection system for the magnets are described. Finally, an overview of the helium-steam generating plant and detailed cost data for the plant, the nuclear island and the magnet are presented. (auth)

4313 (ORNL-TM—5042) **Oak Ridge Tokamak experimental power reactor study reference design.** Roberts, M.; Bettis, E.S. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 133p. Dep. NTIS $7.60.

A Tokamak EPR Reference Design is presented as a basis for further design study leading to a Conceptual Design. The set of basic plasma parameters selected—minor radius of 2.25 m, major radius of 6.75 m, magnetic field on axis of 4.8 T and plasma current of 7.2 MA—should produce a reactor-grade plasma with a significant neutron flux, even with the great uncertainty in plasma physics scaling from present experience to large sizes. Neutronics and heat transfer calculations coupled with mechanical design and materials considerations were used to develop a blanket and shield capable of operating at high temperature, protecting the surrounding coils, being maintained remotely and, in a few experimental modules, breeding tritium. Nb_3Sn and NbTi superconductors are

used in the toroidal field coil design. The coil system was developed for a maximum field of 11 T at the winding (to give a field on axis of 4.8 T), and combines multifilamentary superconducting cable with forced flow of supercritical helium enclosed in a steel conduit. The structural system uses a stainless steel center bucking ring and intercoil box beam bracing to provide rigid support for coils against the centering force, overturning moments from poloidal fields and faults, other external forces, and thermal stresses. The poloidal magnetics system is specially designed both to reduce the total volt-second energy requirements and to reduce the magnitude of the rate of field change at the toroidal field coils. The rate of field change imposed upon the toroidal field coils is reduced by at least a factor of 3.3 compared to that due to the plasma alone. Tritium processing, tritium containment and vacuum systems employ double containment and atmospheric cleanup to minimize releases. The document also contains discussions of systems integration and assembly, key research and development needs, and schedule considerations. (auth)

4314 (UCRL—51797) **Progress on the conceptual design of a mirror hybrid fusion—fission reactor.** Moir, R.W.; Lee, J.D.; Burleigh, R.J. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 25 Jun 1975. Contract W-7405-Eng-48. 155p. Dep. NTIS $7.60.

A conceptual design study was made of a fusion-fission reactor for the purpose of producing fissile material and electricity. The fusion component is a D-T plasma confined by a pair of magnetic mirror coils in a Yin-Yang configuration and is sustained by neutral beam injection. The neutrons from the fusion plasma drive the fission assembly which is composed of natural uranium carbide fuel rods clad with stainless steel and helium cooled. It was shown conceptually how the reactor might be built using essentially present-day technology and how the uranium-bearing blanket modules can be routinely changed to allow separation of the bred fissile fuel. (MOW)

4315 (UCRL—77245) **2XIIB status.** Bulmer, R.H.; Calderon, M.O.; Hibbs, S.M.; Kozman, T.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 7 Nov 1975. Contract W-7405-Eng-48. 6p. (CONF-751125—27). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The 2XIIB CTR facility at LLL is described with emphasis on the engineering aspects of recent modifications. The current version of the 2X series of magnetic confinement experiments has been operating since the fall of 1974. The 2XIIB relies on pulsed-mirror coils to trap axially-injected low-energy ions. Subsequent heating of the ions is accomplished by energizing additional mirror coils to compress the plasma. Experiments prior to 2XIIB demonstrated plasma trapping and confinement in the pulsed mode. The new feature of 2XIIB is intense beams of electrically neutral atoms that heat the target plasma and sustain its classical losses. The principal goal of on-going experiments is to demonstrate scaling of the eta tau product with mean ion energy via neutral beam injection. This paper is an overview of the engineering developments of the past two years and an introduction to more detailed reports presented at this symposium. (auth)

4316 **Fusion power by magnetic confinement: plans and the associated need for nuclear engineers.** Hirsch, R.L.; Beard, D.S. (Energy Research and Development Administration, Washington, DC). *Nucl. Technol.*; **27**: No. 1, 84-91(Sep 1975).

An essential ingredient in the fusion development plan will be the training of appropriate scientific and technical manpower. In examining the need for fusion-trained nuclear engineers, it is projected that an additional 120 to 250 engineers at the MS and PhD levels will be needed between now and 1980. To be most effective, these graduates must not only be trained in the "classic" physical, nuclear, mechanical, and electrical sciences, but they will need specialized training in fusion plasma physics and fusion materials science. To help develop the appropriate educational programs, close cooperation between U. S. Energy Research and Development Administration (ERDA) headquarters, ERDA laboratories, private industry, and the universities will be essential. An emerging need for a carefully structured "fusion technology" option in nuclear engineering departments is plainly evident and is already beginning to be developed at leading institutions. (auth)

4317 **Fusion physics and engineering: a part of the nuclear engineering curriculum.** Kammash, T. (Univ. of Michigan, Ann Arbor). *Nucl. Technol.*; **27**: No. 1, 92-95(Sep 1975).

A new breed of nuclear engineers will be needed in the years preceding demonstration of scientific feasibility of controlled thermonuclear reactions (expected in the early 1980's) and for many decades afterwards to help solve the technological problems and to ultimately design, man, and operate fusion power reactors. A comprehensive graduate training program in "fusion science and engineering" for this new breed of engineers is proposed. (auth)

4318 **Teaching and research in fusion plasmas and technology at the University of Illinois.** Miley, G.H.; Southworth, F.H. (Univ. of Illinois, Urbana). *Nucl. Technol.*; **27**: No. 1, 96-106(Sep 1975).

Teaching in fusion at the University of Illinois is an integrated part of the nuclear engineering curriculum. Through the use of two key courses, "Introduction to Fusion" and "Fusion Systems," basic preparation for those wishing to specialize in fusion is provided. These courses are primarily directed to plasma aspects of fusion, but materials and other engineering aspects have been integrated into the curriculum through a broadened coverage in such existing courses as nuclear materials, shielding, and reactor physics. Research is primarily focused at the PhD level, although some MS studies are in progress. While current theses involve a wide variety of topics, one major area being pursued is the study of advanced fuel (non-deuterium-tritium) reactors based on two-component fusion and other concepts. This effort consists of a series of loosely knit subtasks related to such problems as cyclotron emission and direct energy conversion. Also, various research involving charge-exchange losses during neutral-beam injection, vacuum-wall sputtering, and related topics has developed as a direct outgrowth of the PROMETHEUS project, which involved the conceptual design of a power-consuming mirror-type reactor for materials and engineering tests. (auth)

4319 **Computer applications in controlled fusion research.** Killeen, J. (Univ. of California, Davis). *Nucl. Technol.*; **27**: No. 1, 107-113(Sep 1975).

The application of computers to controlled thermonuclear research (CTR) is essential. In the near future the use of computers in the numerical modeling of fusion systems should increase substantially. A recent panel has identified five categories of computational models to study the physics of magnetically confined plasmas. A comparable number of types of models for engineering studies is called for. The development and application of computer codes to implement these models is a vital step in reaching the goal of fusion power. To meet the needs of the fusion program the National CTR Computer Center has been established at the Lawrence Livermore Laboratory. A large central computing facility is linked to smaller computing centers at each of the major CTR Laboratories by a communication network. The crucial element needed for success is trained personnel. The number of people with knowledge of plasma science and engineering trained in numerical methods and computer science must be increased substantially in the next few years. Nuclear engineering departments should encourage students to enter this field and provide the necessary courses and research programs in fusion computing. (auth)

4320 **Evaluation of fusion research and instruction at the University of Wisconsin.** Maynard, C.W. (Univ. of Wisconsin, Madison). *Nucl. Technol.*; **27**: No. 1, 114-118(Sep 1975).

The University of Wisconsin fusion research program is divided between plasma physics and fusion reactor technology studies. Both research and teaching are the integrated efforts of several departments, with a substantial number of courses available to both graduate and undergraduate students. The program has been successful in producing students for the national controlled thermonuclear research program. It has also produced significant research results, particularly in the toroidal confinement and conceptual reactor design fields. (auth)

PHYSICS AND BLANKET ENGINEERING

4321 (CONF-751026—14) **Chemical equilibrium studies of tritium—lithium and tritium—lithium alloy systems.** Smith, F.J.; Land, J.F.; Talbot, J.B.; Bell, J.T. (Oak Ridge National Lab., Tenn. (USA)). 1975. 16p. Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

In deuterium-tritium fusion reactors currently under design, the production of tritium is accomplished by utilizing a lithium-bearing blanket. Lithium metal is presently the leading candidate for the blanket material, although molten Li_2BeF_4, solid Li—Al (50-50 at. percent) alloy and other lithium-containing materials are distinct possibilities. This paper summarizes progress of ongoing studies of the thermodynamics of some of these lithium containing systems. The individual solubilities of hydrogen, deuterium, and tritium in lithium as a function of temperature (700 to 1000°C) and pressure are presented. Recent work with the solid alloy Li—Al (50-50 at. percent) has shown that the tritium solubility between 400 and 600°C is low. When the tritium pressure was between 0.14 and 0.52 torr, the Li—Al samples contained only 1 to 4 ppm tritium. (auth)

4322 (LA-UR—75-351) **Application of Bondarenko formalism to fusion reactors.** Soran, P.D.; Dudziak, D.J. (Los Alamos

Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 8p. (CONFn750364—1). Dep. NTIS $4.50.

From Conference on neutron cross section and technology; Washington, District of Columbia, USA (3 Mar 1975).

The Bondarenko formalism used to account for resonance self-shielding effects (temperature and composition) in a Reference Theta-Pinch Reactor is reviewed. A material of interest in the RTPR blanket is ^{93}Nb, which exhibits a large number of capture resonance in the energy region below 800 keV. Although Nb constitutes a small volume fraction of the blanket, its presence significantly affects the nucleonic properties of the RTPR blanket. The effects of self-shielding in ^{93}Nb on blanket parameters such as breeding ratio, total afterheat, radioactivity, magnet-coil heating and total energy depositions have been studied. Resonance self-shielding of ^{93}Nb, as compared to unshielded cross sections, will increase tritium breeding by approximately 7 percent in the RTPR blanket and will decrease blanket radioactivity, total recoverable energy, and magnet-coil heating. Temperature effects change these parameters by less than 2 percent. The method is not restricted to the RTPR, as a single set of Bondarenko f-factors is suitable for application to a variety of fusion reactor designs. (auth)

MAGNET COILS AND FIELDS

4323 (ANL/HEP-CP—66) **Superconducting OHMIC-heating coils for the Argonne TEPR design study.** Turner, L.R.; Wang, S.T.; Purcell, J.R. (Argonne National Lab., Ill. (USA)). 1975. 5p. (CONF-751125—13). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A system of air-core superconducting ohmic-heating coils was studied for the Argonne TEPR design. The OH coil requirements, the basis for the choice, and a suitable conductor are described. A 3.6 m diameter, 13 m long solenoid plus ten other coils with diameters up to 23 m provide (together with the equilibrium coils) the needed 110 volt-sec flux change while producing little magnetic field at the plasma region or at the toroidal field coils. (auth)

4324 (CONF-751125—44) **Optimization of the ECT background coil.** Ballou, J.K.; Luton, J.N. (Oak Ridge National Lab., Tenn. (USA)). 1975. 5p. Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

This study was begun to optimize the Eccentric Coil Test (ECT) background coil. In the course of this work a general optimization code was obtained, tested, and applied to the ECT problem. So far this code has proven to be very satisfactory. The results obtained with this code and earlier codes have illustrated the parametric behavior of such a coil system and that the optimum for this type system is broad. This study also shows that a background coil with a winding current density of less than 3000 A/cm^2 is not feasible for the ECT models presented in this paper. (auth)

4325 (LA-UR—75-1567) **Hybrid model studies of magnetic field diffusion in high-β pinches.** Sgro, A.G.; Nielson, C.W. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 5p. (CONF-750944—13). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A hybrid model was derived which includes all nontrivial field components and an anisotropic anomalous resistivity. It was applied to the ZT-1 reverse field diffuse pinch. For a proper choice of anomalous resistivity, the calculated and observed fields are in good agreement. Impurities are found to cause the plasma to implode to a smaller radius and to result in lower electron temperatures and higher ion temperatures. (auth)

4326 (MATT—1079) **Effects of impurities and magnetic divertors on high-temperature tokamaks.** Meade, D.M.; Furth, H.P.; Rutherford, P.H.; Seidl, F.G.P.; Duechs, D.F. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 16p. (IAEA-CN—33/A15-4). Dep. NTIS $4.00.

A one-dimensional tokamak plasma transport code has been adapted to include impurity influx, stripping, radiation, and diffusion, as well as the usual processes of hydrogen plasma and heat transport, recycling at the boundary, and multigeneration charge-exchange. Neutral-beam heating, adiabatic compression, and divertor boundary conditions are included as optional features. Illustrative computations are given for present-day and next-generation tokamaks. The problems of impurity control are discussed, and two technical approaches are examined in greater detail: the transient cold-plasma shield, and the poloidal divertor. (auth)

4327 (MATT—1083) **Test results of Nb_3Sn ribbons for the Princeton D coil test program.** Kaugerts, J.; File, J.; Willard, J.W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1974. Contract AT(11-1)-3073. 5p. Dep. NTIS $4.00.

A previously described D coil test program was modified. Details of a smaller Nb_3Sn D coil test program are described. Cusp coil tests were made with several Nb_3Sn composite ribbons. Measurements of both the quench and recovery currents as a function of magnetic field component perpendicular to the wide edge of the ribbon are presented. (auth)

4328 (MATT—1134) **Magnetic fields from straight filaments, rectangular sheets, and rectangular bars.** Christensen, U.R.; Weissenburger, D.W.; Dreskin, S.A. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Aug 1975. Contract AT(11-1)-3073. 21p. Dep. NTIS $4.25.

The derivation and the use of three Fortran programs are described: FIFL = Field from a straight filament of finite length. FIRS = Field from a rectangular sheet of infinitesimal thickness. FIRB = Field from a rectangular bar of finite length. The three geometries in question might suggest a logical extension of the solution for the simplest geometry, i.e., the linear filament, into the successively more complicated cases, i.e., the rectangular sheet and the rectangular bar. The programs to be discussed were; however, developed independently. Each program is, therefore, the result of a different mathematical approach and is discussed. (auth)

4329 (MATT—1159) **Toroidal field coils for the Princeton Divertor Experiment.** Citrolo, J.C.; Bushnell, C.W. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Oct 1975. Contract E(11-1)-3073. 20p. (CONF-750438—10). Dep. NTIS $4.00.

From 5. international conference on magnet technology; Frascati, Italy (21 Apr 1975).

The toroidal field coils for the Princeton Divertor Experiment (PDX) and their supporting structure are described. The special demountable nature of the coils and the problems which result from this feature are discussed. The procedures for assembly and fabrication of the coils are presented. (auth)

4330 (MATT—1187) **On current penetration and plasma disruption.** Stix, T.H. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1975. Contract E(11-1)-3073. 14p. Dep. NTIS $4.00.

It is suggested that, in a tokamak discharge, the initial rapid current penetration and the disruptive instability may each be attributed to a type of nonlinear double tearing instability which causes growth and overlap of radially separated magnetic islands. The ensuing reconnection and braiding of magnetic lines would enhance local radial heat and particle transport, and could permit rapid redistribution of plasma current, inducing positive or negative spikes in the loop-voltage signal. (auth)

4331 (UCRL—77229) **Electrical insulation for large multiaxis superconducting magnets.** Harvey, A.R.; Rinde, J.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 30 Oct 1975. 5p. (CONF-751125—31). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The selection of interturn and interlayer insulation for superconducting magnets is discussed. The magnet problems of the Baseball II device are described. Manufacture of the insulation and radiation damage are mentioned. A planned experimental program is outlined. (MOW)

4332 **Superconducting toroidal magnets for fusion feasibility experiments and power reactors.** Lubell, M.S. (Oak Ridge National Lab., TN). pp 164-173 of In Proceedings of the fifth international cryogenic engineering conference. Mendelssohn, K. (ed.). Guildford, Eng.; IPC Science and Technology Press Ltd. (1974).

From 5. international cryogenic engineering conference; Kyoto, Japan (7 May 1974).

See CONF-740509—.

It has been recognized that large superconducting magnets will have to be developed in order to obtain power economically from a thermonuclear reactor. In the present paper, we offer compelling reasons to illustrate how vital they are even for the sizes envisioned for hydrogen feasibility and D-T burning experiments. Detailed discussion is given on the type of magnets used for the plasma confinement in a tokamak-type machine. Illustrations are given to show that their development is within the present technological progress of superconductivity. The methods used to estimate the cost of such a toroidal system are provided along with how the cost varies with changes in magnet aspect ratio, major radius (varies as $R^{1.95}$), and stored energy (varies as $E^{0.65}$/sub s/). The latter quantity is presented as a valid figure of merit for quickly estimating the cost of any large superconducting toroidal system. (auth)

POWER SUPPLIES AND CIRCUITRY

4333 (LA-UR—75-2115) **10 kA low resistance superconducting switch.** Lindsay, J.D.G.; Blevins, D.J. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-751125—57). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A low resistance superconducting switch for use in initiating transfer of energy from an inductive energy storage coil has been constructed and tested at Los Alamos Scientific Laboratory. The switch will be used in series with a mechanical circuit breaker to reduce the current through the breaker prior to its opening. Both mechanical breaker and switch are immersed in liquid helium. Opening the switch before the mechanical breaker will reduce arcing and burning of the mechanical breaker contacts and reduce the rate at which the heat generated during the switching operation is deposited into the helium bath. A detailed description of the switch design and construction is given as well as the initial design parameters and test results. A circuit diagram of the switching scheme and a discussion of the circuit is also given. (auth)

4334 (LA-UR—75-2127) **HVDC interrupter experiments for large Magnetic Energy Transfer and Storage (METS) systems.** Swannack, C.E.; Haarman, R.A.; Lindsay, J.D.G.; Weldon, D.M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 5p. (CONF-751125—56). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

Proposed fusion-test reactors will require energy storage systems of hundreds of megajoules with transfer times of the order of one millisecond. The size of the energy storage submodule (and hence, the overall system cost and complexity) is directly determined by the voltage and current limits of the switch used for the energy transfer. Experiments are being conducted on high voltage dc circuit breakers as a major part of the energy storage, pulsed power program. DC circuit interruption characteristics of a commercially available ac power vacuum interrupter are discussed. Preliminary data of interruption characteristics are reported for an interrupter developed specifically to match a present METS circuit requirement. (auth)

FUEL SYSTEMS

4335 (UCRL—76706) **Estimated D_2-DT-T_2 phase diagram in the three-phase region.** Souers, P.C.; Hickman, R.G.; Tsugawa, R.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 26 Aug 1975. 16p. (CONF-751026—11). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

A composite of experimental eH_2-D_2 phase-diagram data at the three-phase line is assembled from the literature. The phase diagram is a smooth cigar shape without a eutectic point, indicating complete miscibility of liquid and solid phases. Additional data are used to estimate the D_2-T_2, D_2-DT, and DT-T_2 binary phase diagrams. These are assembled into the ternary D_2-DT-T_2 phase diagram. A surface representing the chemical equilibrium of the three species is added to the phase diagram. At chemical equilibrium, it is estimated that 50-50 liquid D-T at 19.7 K is in equilibrium with 42 mole percent T vapor and 54 percent T solid. Infrared spectroscopy is suggested as a means of component analysis of liquid and solid mixtures. (auth)

4336 (UCRL—76707) **Secondary containment system for a high tritium research cryostat.** Tsugawa, R.T.; Fearon, D.; Souers, P.C.; Hickman, R.G.; Roberts, P.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Sep 1975. 11p. (CONF-751026—12). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

A 4.2- to 300-K liquid helium cryostat was constructed for cryogenic samples of D-T containing up to 4×10^{14} dis/s (10,000 Ci) of tritium radioactivity. The cryostat is enclosed in a secondary box, which acts as the ultimate container in case of a tritium release. Dry argon is flushed through the box, and the box atmosphere is monitored for tritium, oxygen, and water vapor. A rupture disk and abort tank protect the box atmosphere in case the sample cell breaks. If tritium breaks into the box, a powdered uranium getter trap reduces the 4×10^{14} dis/s (10,000 Ci) to 4×10^{9} dis/s (0.1 Ci) in 24 h. A backup palladium-zeolite getter system goes into operation if an overabundance of oxygen contaminates the uranium getter. (auth)

4337 **Low energy x-ray microradiography of laser fusion targets.** Prevender, T.S.; Lynch, A.W. (Sandia Labs., Albuquerque, NM). *Mater. Eval.*; **33**: No. 10, 246-248(Oct 1975).

A low-energy x-ray radiography apparatus was developed primarily for the nondestructive inspection of LiD laser fusion targets. Exposure times of 15 min at 6 keV were found satisfactory for the detection of voids in nominal 100-micron diam spheres. (auth)

RADIATION HAZARDS

4338 (BNL—20563) **Tritium recovery from fusion blankets using solid lithium compounds.** Powell, J.R.; Wiswall, R.H.; Wirsing, E. (Brookhaven National Lab., Upton, N.Y. (USA)). Oct 1975. 50p. Dep. NTIS $5.45.

Separate abstracts were prepared for the two included papers. (MOW)

4339 (BNL—20563, pp 1-28) **Tritium recovery from fusion blankets using solid lithium compounds. I. Design and minimization of tritium inventory.** Powell, J.R. Oct 1975.

In Tritium recovery from fusion blankets using solid lithium compounds.

Tritium blanket inventories of 100 curies/MW(e) are readily achievable, and inventories as low as 10 curies/MW(e) are possible for blankets with small lithium compound particulates (less than or equal to 50μ) at T greater than or equal to 800°C. Of the three release modes [A - to the main coolant (e.g., He) stream; B - to a separate processing circuit; and C - to the plasma region], mode A appears optimum for blankets using gas-cooled metallic structures (e.g., Al, stainless), while mode C appears optimum for high temperature refractory (e.g., C, SiC) structures. The greater structural complexity of mode B makes it less attractive than modes A and C. No recovery method is required for mode C release. With mode A release, tritium inventory in the coolant circuits ranges from 1 to 10 curies/MW(e), depending on processing parameters. Tritium leak rates to the environment during normal operation can be kept to less than or equal to 10^{-3} curies/MW(e) per day with low permeability barriers. In general, a mixture of T_2 and T_2O is present in the coolant stream. Three methods of tritium recovery are examined: (1) Conversion to T_2 followed by absorption in a metal hydride bed. (2) Conversion to T_2 followed by condensation at approximately 6°K. (3) Conversion to T_2O followed by condensation at approximately 100°K. (auth)

4340 (BNL—20563, pp 29-40) **Tritium recovery from fusion blankets using solid lithium compounds. II. Experiments on tritium removal and absorption.** Wiswall, R.H.; Wirsing, E. Oct 1975.

In Tritium recovery from fusion blankets using solid lithium compounds.

It was shown experimentally that tritium can be easily removed from certain solid lithium compounds that have been proposed as components of CTR breeder blankets. The compounds tested were LiAl, Li_7Pb_2, $LiAlO_2$ and Li_2SiO_3 in granular or powder form; the procedure was to pass a stream of helium through a bed of material maintained at a temperature in the range 400-600°C. As the tritium, which had been previously generated in the materials by exposure to thermal neutrons, diffused out and was carried away, its concentration was continuously monitored by radioactive assay of the gas stream. From the data, it was possible to calculate average lifetimes of tritium in a continuously extracted breeder blanket. Lifetimes of a few hours were found for LiAl and Li_7Pb_2 at 400-500°, $LiAlO_2$ at 600° and Li_2SiO_3 at 500-600°. The extraction kinetics of $LiAlO_2$ were consistent with a diffusion-controlled process, and it was possible to calculate diffusion coefficients from the data. A series of hydride-forming metals were tested for their ability to trap out tritium from dilute helium streams and later release it on heating. Vanadium appears to be satisfactory. (auth)

4341 (BNWL-SA—5415) **Definition of source terms for tritium evolution from CTR systems.** Kabele, T.J.; Johnson, A.B.; Mudge, L.K. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 20p. (CONF-751026—26). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The tritium source terms for several fusion power reactor reference designs are discussed. These reference or conceptual designs have been analyzed to determine, where possible, the amounts and locations of tritium sources within the plants and the pathways for tritium escape to the environment. (MOW)

4342 (BNWL-SA—5481) **Analysis of tritium releases to the atmosphere by a CTR.** Renne, D.S.; Sandusky, W.F.; Dana, M.T. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). Aug 1975. Contract AT(45-1)-1830. 52p. (CONF-750967—18). Dep. NTIS $5.50.

From 3. ERDA environmental protection conference; Chicago, Illinois, USA (23 Sep 1975).

Removal by atmospheric processes of routinely and accidentally released tritium from a controlled thermonuclear reactor (CTR) was investigated. Based on previous studies, the assumed form of the tritium for this analysis was HTO or tritiated water vapor. Assuming a CTR operation in Morris, Illinois, surface water and ground-level air concentration values of tritium were computed for three space (or time) scales: local (50 Km of a plant), regional (up to 1000 Km of the plant), and global. (auth)

4343 (CONF-751026—15) **Tritium permeation through steam generator materials.** Bell, J.T.; Strehlow, R.A.; Redman, J.D.; Smith, F.J. (Oak Ridge National Lab., Tenn. (USA)). 1975. 11p. Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

A model is developed for hydrogen isotope permeation through metals that have one side coated with a material through which the transport of hydrogen is directly dependent on the pressure of hydrogen. (MOW)

4344 (SAND—75-8653) **Containment and decontamination systems planned for the Tritium Research Laboratory building at Sandia Laboratories, Livermore.** Gildea, P.D. (Sandia Labs., Livermore, Calif. (USA)). Oct 1975. Contract AT(29-1)-789. 21p. (CONF-751026—30). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Sandia Laboratories, Livermore, is constructing a new facility, the Tritium Research Laboratory, that incorporates containment and cleanup facilities which hold any tritium that is accidentally released rather than allow the material to be vented to the atmosphere. This containment is achieved with hermetically sealed glove boxes that are connected on demand by manifolds to two central decontamination systems called the Gas Purification System (GPS) and the Vacuum Effluent Recovery System (VERS). The primary function of the GPS is to remove tritium and tritiated water vapor from the glove box atmosphere. The primary function of the VERS is to decontaminate the gas exhausted from the vacuum pumps in the building before venting this gas to the stack. (auth)

4345 (UCRL—76734) **Collection of deuterium on a uranium getter during dynamic flow conditions.** Folkers, C.L.; Singleton, M.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Sep 1975. Contract W-7405-Eng-48. 13p. (CONF-751026—19). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

We have studied uranium as a getter material under varying flow conditions using a uranium trap designed to remove tritium from inert gases. The uranium trap can remove any hydrogen isotope from an inert gas. We used mixtures of deuterium in argon at room temperatures. In the case of tritium, recovery is effected by heating the trap. A special segmented trap was designed to prevent channeling and to promote maximum reaction rates when gas flows through it. The gas mixtures were sampled at the trap inlet and outlet and were analyzed by a mass spectrometer. The results are expressed as a purification factor, which is the ratio of deuterium concentration at the inlet of the uranium trap to the concentration at the outlet. Purification factors vary inversely with both the ratio of deuterium to uranium already contained in the trap and with the rate of flow of gas through the trap. The effects of varying inlet deuterium concentrations on purification factors are also discussed. (auth)

4346 (UCRL—76911) **Fusion power and the environment.** Holdren, J.P.; Fowler, T.K.; Post, R.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 2 Jun 1975. 22p. (CONF-750697—1). Dep. NTIS $4.00.

From Proceedings of energy and the environment - cost benefit analysis; Atlanta, Georgia, USA (23 Jun 1975).

Environmental characteristics of conceptual fusion-reactor systems based on magnetic confinement are examined quantitatively, and some comparisons with fission systems are made. Fusion, like all other energy sources, will not be completely free of environmental liabilities, but the most obvious of these—tritium leakage and activation of structural materials by neutron bombardment—are susceptible to significant reduction by ingenuity in choice of materials and design. Large fusion reactors can probably be designed so that worst-case releases of radioactivity owing to accident or sabotage would produce no prompt fatalities in the public. A world energy economy relying heavily on fusion could make heavy demands on scarce nonfuel materials, a topic deserving further attention. Fusion's potential environmental advantages are not entirely "automatic", converting them into practical reality will require emphasis on environmental characteristics throughout the process of reactor design and engineering. The central role of environmental impact in the long-term energy dilemma of civilization justifies the highest priority on this aspect of fusion. (auth)

4347 (UCRL—77237) **Fusion reactors: a remote possibility.** Doggett, J.N. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. 5p. (CONF-751125—32). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

The next generation of controlled thermonuclear reactor experiments will be faced with the handling problems of tritium and neutron activation that will dominate the safety and maintenance problems of future fusion reactors. The nuclear industry has been working with highly radioactive systems for many years and has developed the tools and methods to do safely productive work in the presence of high radiation fields. These methods can be applied to CTR work by extending them to the unique problems associated with fusion reactors. (auth)

POWER CONVERSION SYSTEMS

4348 **Thermal power conversion systems for fusion plants.** Sager, P.H. Jr. (General Atomic Co., San Diego, CA). pp 320-328 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The type of power conversion system is dependent upon the coolant used in the fusion reactor. For a direct coolant system where coolant is also used as a fertile material for breeding tritium, lithium and flibe ($LiF\text{-}BeF_2$) appear to be suitable. For indirect coolants where the coolant is circulated through the blanket material, lithium, boiling sodium, and helium appear to be the most attractive candidates. Among the power conversion systems, the steam turbine, gas turbine, gas turbine-ammonia binary cycle, potassium-steam binary cycle and potassium-diphenyl-steam ternary cycle systems used with various primary and intermediate coolant loops appear to offer the most promise. (auth)

4349 **Environmental aspects of fusion reactors.** Coffman, F.E.; Williams, J.M. (Energy Research and Development Administration, Washington, DC). *Nucl. Technol.*; **27**: No. 1, 174-181(Sep 1975).

With the continued depletion of fossil and uranium resources in the coming decades, the U. S. will be forced to look more toward renewable energy resources (e.g., wind, tidal, geothermal, and solar power) and toward such longer-term and nondepletable energy resources as fissile fast breeder reactors and fusion power. Several reference reactor designs have been completed for full-scale fusion power reactors that indicate that the environmental impacts from construction, operation, and eventual decommissioning of fusion reactors will be quite small. The principal environmental impact from fusion reactor operation will be from thermal discharges. Some of the safety and environmental characteristics that make fusion reactors appear attractive include an effectively infinite fuel supply at low cost, inherent incapability for a "nuclear explosion" or a "nuclear runaway," the absence of fission products, the flexibility of selecting low neutron-cross-section structural materials so that emergency core cooling for a loss-of-coolant or other accident will not be necesary, and the absence of special nuclear materials such as ^{233}U or ^{239}Pu, so that diversion of nuclear weapons materials will not be possible and nuclear blackmail will not be a serious concern. (auth)

INERTIAL CONFINEMENT SYSTEMS

4350 (SAND—75-5691) **Electron beam fusion targets.** Sweeney, M.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 12 Sep 1975. 17p. (CONF-750943—1). Dep. NTIS $4.00.

From Conference of the department of physics and astronomy; Albuquerque, New Mexico, USA (12 Sep 1975).

Focused relativistic electron beams are receiving considerable attention as a means of imploding spherical targets a few millimeters in diameter to produce substantial thermonuclear yields. A central consideration of such proposals is the design of the targets and, in particular, design calculations which concentrate on reducing breakeven power levels. The behavior of e-beam fusion targets in which a low-Z (iron or carbon) ablator surrounds a high-Z, high-density (gold) pusher is compared to that of single gold shell targets. Both types of DT-filled targets are irradiated by con-

stant-power 1-MeV electron beam pulses. The use of a low-Z ablator decreases the bremsstrahlung heating of the pusher. The resulting colder and denser pusher is more effective. Breakeven requires about 360 TW of power deposited for 8 ns with iron ablators; 220 TW deposited for 12 ns with high-density (3.52 g/cm^3) carbon ablators. This is less than half the power required for targets composed of a single DT-filled gold shell (800 TW deposited for 5 ns). (auth)

4351 (SAND—75-5751) **Ion beam generation and focusing.** Miller, P.A.; Mendel, C.W.; Swain, D.W.; Goldstein, S.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 22p. (CONF-751108—5). Dep. NTIS $4.50.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Calculations have shown that efficiently generated and focused ion beams could have significant advantages over electron beams in achieving ignition of inertially-confined thermonuclear fuel. Efficient ion beam generation implies use of a good ion source and suppression of net electron current. Net electron flow can be reduced by allowing electrons to reflex through a highly transparent anode or by use of transverse magnetic fields (either beam self-fields or externally applied fields). Geometric focusing can be achieved if the beam is generated by appropriately shaped electrodes. Experimental results are presented which demonstrate ion beam generation in both reflexing and pinched-flow diodes. Spherically shaped electrodes are used to concentrate a proton beam and target response to proton deposition is studied. (auth)

4352 (SAND—75-5765) **Anode plasma and focusing reb diodes.** Goldstein, S.A.; Swain, D.W.; Hadley, G.R.; Mix, L.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 27p. (CONF-751108—9). Dep. NTIS $5.00.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

The use of electrical, optical, x-ray, and particle diagnostics to characterize the production of anode plasma and to monitor its influence on beam generation and focusing is reviewed. Studies using the Nereus accelerator show that after cathode turn-on, deposition of several kJ/gm on the anode is necessary before ions from hydrocarbons, adsorbed gases, and heavier metallic species are detected. The actual time at which ions are liberated depends on several factors, one of which is the specific heat of the anode substrate. Once formed, anode ions cross the A-K gap (with an energy equal to the diode voltage) and interact with the cathode to produce an axially peaked beam profile, a "pinch" which does not follow the critical current criterion. Experiments with externally generated anode plasma show that this type of pinch can be attracted to localized areas on the anode. Preliminary observations on Hydra indicate the anode plasma composition is similar to that on Nereus. The effect of this plasma on pinch dynamics currently is under investigation. (auth)

4353 (SAND—75-5803) **Proto-I switching and diode studies.** Prestwich, K.R.; Miller, P.A.; McDaniel, D.H.; Poukey, J.W.; Widner, M.M.; Goldstein, S.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 43p. (CONF-751108—12). Dep. NTIS $5.00.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

Proto-I is a 3 MV, 800 kA, 24 ns electron beam accelerator that is under development at Sandia Laboratories. It represents an initial effort to develop a scalable technology that is applicable to accelerators for electron beam driven, inertial confinement fusion studies. Energy is supplied to each of the two diodes from six oil-dielectric Blumlein transmission lines (PFL) operating in parallel. A Marx generator charges three intermediate storage, water-dielectric capacitors which subsequently transfer the stored energy to the PFL. The discharge of the PFL is initiated by the simultaneous closure of 12 triggered oil-dielectric rail switches. Data will be presented on the operation of these multichannel switches. The two diodes have a common anode. Cathode diameters can be varied from 10 to 60 cm. Results of initial diode experiments and comparisons with theory are discussed. Plasma filled diode experiments are also reported, indicating pinch collapse velocities in excess of 10^9 cm/s. (auth)

4354 (UCRL—76573) **Magnetic and inertial CTR: present status and outlook.** Wood, L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Jan 1975. 31p. (CONF-750110—8). Dep. NTIS $5.00.

From Orbis scientist meeting; Coral Gables, Florida, USA (21 Jan 1975).

Some of the successes of controlled fusion research in both inertial confinement and magnetic confinement are described. The possibilities of scaled-up experiments are also discussed with respect to cost and economics. (MOW)

4355 (UCRL—77057) **Behavior of fluid instabilities in laser fusion pellets: results of 2-D calculations.** Mead, W.C.; Lindl, J.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Jul 1975. 20p. (CONF-750841—1). Dep. NTIS $4.00.

From Gordon research conference on laser interaction with matter; Tilton, New Hampshire, USA (18 Aug 1975).

Two-dimensional Lagrangian hydrodynamics simulation techniques were used to study fluid instability in laser fusion pellets. A slab geometry comparison with classical Rayleigh-Taylor theory shows good agreement, as do other slab and spherical test problems over a wide range of accelerations and wavelengths. Isentropic ablative accelerations exhibit growth rates 50 percent-100 percent of classical values, while non-isentropic cases show suppressed growth. Design optimization at 100 kJ input energy has led to an impulsively accelerated, low-aspect-ratio shell which operates successfully with a surface perturbation of a few tens of angstroms. Comparison of simulations with present experiments indicates that current neutron-producing targets are insensitive to damage from fluid instability. (auth)

4356 **Engineering concepts for laser-fusion reactor applications.** Booth, L.A.; Frank, T.G.; Finch, F.T. (Los Alamos Scientific Lab., NM). Contract W-7405-eng-36. pp 314-319 of In Tenth intersociety energy conversion engineering conference. New York; Inst. of Electrical and Electronics Engineers, Inc. (1975).

From 10. intersociety energy conversion engineering conference; Newark, Delaware, USA (17 Aug 1975).

See CONF-750812—.

The long-range goal of the ERDA Laser Fusion Program is the production of commercial electric power. Although the scientific feasibility of significant thermonuclear energy release from laser-imploded and -heated pellets remains to be demonstrated, significant progress has been made, and many technological problems associated with ultimate applications of laser fusion are being investigated. Preliminary evaluations of several laser fusion reactor concepts have been made, and the most promising concepts, employing different methods for protecting structural components from damage by the products of fusion-pellet microexplosions, are being studied in detail. Engineering design and feasibility studies of other electric generating station subsystems are also under way. Continuing overall economic and technology tradeoff studies assess the economic pontential of various generating station concepts and provide guidance for research and development programs. (auth)

4357 **Fusion induced by relativistic electron beams.** Chang, J.; Clauser, M.J.; Freeman, J.R. (Sandia Labs., Albuquerque, NM). pp 347-354 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Recent progress in the Sandia REB Fusion Program is reviewed including theoretical and experimental results on focusing, deposition, and pellet implosion. Measurements of time-dependent pinching of the beam are compared with numerical models including diode plasmas. The self-field of a beam has been included in a beam-deposition model and experiments involving front- and rear-surface diagnostics are presented. Spherical and hemispherical gold shells have been imploded using one and two beams and bremsstrahlung output as well as separate flash radiographs are given. Short-pulse accelerator technology requirements and developments are discussed and an example of a typical pellet design calculation is shown. (auth)

4358 **Laser-plasma experiments relevant to laser-produced implosions.** Ahlstrom, H.G.; Holzrichter, J.F.; Manes, K.R.; coleman, L.W.; Speck, D.R.; Haas, R.A.; Shay, H.D. (Univ. of California, Livermore). pp 375-404 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Preliminary laser-target interaction studies designed to provide code normalization data in a regime of interest to laser fusion are reported. The laser facilities constructed for such studies, the target diagnostic systems, and preliminary experimental results are described. (auth)

4359 Laser-plasma studies of solid pellets irradiated with the Sandia four-beam laser. Powell, J.E.; Beckner, E.H.; Brannon, P.J.; Cano, G.L.; Cuderman, J.F.; Gilbert, K.M.; Palmer, M.A. (Sandia Labs., Albuquerque, NM). pp 487-493 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Experiments are under way at Sandia Laboratories in which spherical CD_2 and LiD pellets are being irradiated in a tetrahedral geometry with four beams of up to 50 J/beam from a Nd:glass laser. Pellets ranging in diameter from 50 to 200 μm have been irradiated with pulses of width 0.97 ns. Of the laser output energy, approximately 35 to 40 percent is absorbed by the target. Most of this energy manifests itself in kinetic energy of the ions. X-ray spectra show simple bremsstrahlung-recombination distributions which indicate electron temperatures in the few hundred eV range. No target neutrons have been observed. CD_2 targets also have been irradiated in a background deuterium gas ranging in pressure from 0.1 to 10 Torr. Neutrons are observed coming from the gas. (auth)

4360 Laser light absorption and reflection in plasmas. Kruer, W.; Valeo, E.; Estabrook, K.; Thomson, J.; Langdon, B.; Lasinski, B. (Univ. of California, Livermore). pp 525-531 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Mechanisms by which intense laser light energy is absorbed or reflected by a hot, dense plasma are of central concern in laser fusion studies. Extensive computer simulations show that the plasma waves responsible for absorption near the critical density are produced by instabilities, resonant excitation and, more generally, by off-resonant coupling by nonlinearly produced ion density fluctuations. Nonlinear modifications in the plasma density profile are found to play a key role in the light absorption. DC magnetic fields large enough to affect electron transport are observed in computer simulations of intense obliquely incident light, even in the absence of irradiation asymmetry. Finally, plasma heating near one-fourth the critical density and the role of bandwidth as a means to control Brillouin reflection are discussed. (auth)

4361 Laser-driven implosion of hollow pellets. Nuckolls, J.; Lindl, J.; Mead, W.; Thiessen, A.; Wood, L.; Zimmerman, G. (Univ. of California, Livermore). pp 535-542 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Implosion of hollow (rather than solid) pellets makes possible order of magnitude reductions in the required laser power and significant reductions in the required laser frequency. However, the symmetry and fluid instability problems are more severe in hollow pellet implosions. These problems have been calculated with the LASNEX two-dimensional multi-group energy transport magnetohydrodynamic computer program. Calculations show that laser-driven implosions of moderately hollow pellets to the superdense Fermi degenerate states required for fusion power production are feasible when the laser power history is tailored to generate an optimum sequence of 5 to 10 weak shocks, the pellet is fabricated with a surface finish accurate to 10 to 100 A and conditions previously described for solid pellets involving the laser wavelength and the initial atmosphere are satisfied. Excessive growth of fluid instabilities destroys implosions of thin-walled hollow pellets driven by smoothly varying pulse shapes otherwise capable of generating the required isentropic high-density states, because the mean acceleration of the imploding shell is too small and because the ablation rate is not large enough to provide effective ablative stabilization. Calculations have also been made of laser-driven implosions of complex hollow pellets containing one or more shells of high-density, high-Z materials (e.g., Fe or U). These pellets do not have high enough gain for laser fusion power production unless the laser efficiency is much greater than 10 percent or unless the reactor is a hybrid (fission-fusion). (auth)

4362 Implosion, stability, and burn of multi-shell fusion pellets. Fraley, G.S.; Gula, W.P.; Henderson, D.B.; McCrory, R.L.; Malone, R.C.; Mason, R.J.; Morse, R.L. (Los Alamos Scientific Lab., NM). pp 543-555 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

Various multi-shell laser/e-beam fusion pellets are described. These include a design with hollow fuel inside a high-Z pusher shell which gives greatly improved performance without extreme pulse shaping. The advantages of multi-shell, multi-material pellets are discussed in general. Stability calculations then show that Taylor instability on both the inside and outside of the shells can amplify perturbations with spherical harmonic l-numbers of the order of 100 by factors exceeding ten thousand. However, by decreasing the shell aspect ratios ($r/\Delta r$) and intensifying the ablation rate, these amplifications can be greatly reduced. Acceptable instability growth seems attainable by using aspect ratios of the order of five or less and/or by operating in a less efficient exploding pusher mode. The effects of tamping by high-Z material on thermonuclear burn are briefly discussed. (auth)

4363 (UCRL-Trans—10942) **Interaction of a high-power laser beam with an LiD target.** Dubovoi, L.V.; Dyatlov, V.D.; Kryzhanovskii, V.I.; Mak, A.A.; Medvedev, R.N.; Popytaev, A.N.; Serebryakov, V.A.; Sizov, V.N.; Starikov, A.D. (Nauchno-Issledovatel'skij Inst. Ehlektrofizicheskoj Apparatury, Leningrad (USSR)). Sep 1975. Translation of NP—20299. 16p. Dep. NTIS $4.50.

A study is presented of the parameters of a plasma produced by a high-power Nd glass laser irradiating an LiD target. Neutron yields of up to 6×10^5 neutrons/4π and electron temperatures of 1 to 2 keV were measured. The reflection coefficient was found as a function of the incident beam intensity. This relationship cannot be explained by a classical interaction mechanism. (auth)

4364 The use of electronic space charge to accelerate, focus, and bunch ions for pellet fusion. Verdeyen, J.T.; Swanson, D.A.; Cherrington, B.E.; Johnson, W.L. (Gaseous Electronics Laboratory, Department of Electrical Engineering, University of Illinois at Urbana-Champaign, Urbana, Illinois 61801). *Appl. Phys. Lett.*; **27**: No. 7, 380-382(1 Oct 1975).

Theoretical arguments are presented which show that electronic space charge can transfer large amounts of energy to ions while simultaneously focusing and bunching their arrival at a small pellet.

COMPONENT DEVELOPMENT AND TESTING

4365 (BNL—20531) **Analysis of radiation damage in fusion-simulation neutron spectra.** Parkin, D.M.; Goland, A.N. (Brookhaven National Lab., Upton, N.Y. (USA)). 1975. 20p. (CONF-751026—21). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Various parameters which are relevant to an understanding of radiation effects in metals have been evaluated utilizing available neutron spectrum information for several existing sources, e.g., EBRII, HFIR, and LAMPF, as well as the hypothetical spectrum at a fusion reactor first wall, and measured Li(d,n) spectra. Recoil energy distributions were calculated for several metals including Al, Cu, and Nb. The recoil energy range was divided into groups, and the fraction of recoils occurring in each energy group was compared with the fraction of the damage energy contributed by that group. From this comparison it was possible to conclude that the significant recoil range differs by about an order of magnitude between fission and fusion sources. The analysis further confirms that basic defect production characteristics depend upon the neutron spectrum, and that integral calculations of radiation-effect parameters do not provide a complete description of the dependence. This is equally true for comparisons between fusion-related spectra or fission-reactor spectra independently. Four recoil-dependent parameter functions which describe different aspects of radiation damage were used in the calculations. The relative effectiveness of neutron sources was found to depend upon the choice of parameter function. Fission-reactor spectra comparisons are relatively insensitive to the parameter functions used whereas spectra with an appreciable component of high-energy neutrons are much more sensitive. (auth)

4366 (BNWL-SA—5376) **Kinetic stability against void coarsening in molbdenum.** Simonen, E.P.; Brimhall, J.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract AT(45-1)-1830. 15p. (CONF-751026—27). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The measured rate of increase of void size in molybdenum with annealing time is found to be slower than expected from the Wagner analysis of diffusion-controlled coarsening. The Wagner theory of surface-reaction-control is also compared with ripening data. The determined surface kinetic parameters are compared

with vacancy diffusivities and are found to be not unrealistic. Furthermore, a measured decrease in void volume during annealing indicates that total void volume is not conserved. These observations support the conclusion that void coarsening is influenced by more than one rate controlling mechanism. A numerical solution to the void annealing problem is obtained and the specific role of volume diffusion, surface kinetics, and annealing of vacancies to sinks other than voids is calculated. (auth)

4367 (BNWL-SA—5398) **Effect of the free surface on void formation in ion bombarded molybedenum.** Bradley, E.R.; Brimhall, J.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 19p. (CONF-751026—28). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Heavy ion bombardment is currently being considered as a technique to simulate neutron damage in CTR components, especially the first wall structure. The use of heavy ion bombardment as a neutron simulation technique has been criticized due to the damage zone being near a free surface (i.e., less than or equal to 1 micron for 5 MeV Ni^{++} ions in molybdenum). The purpose of the present investigation was to examine the microstructure of ion bombarded molybdenum at and below the bombarded surface utilizing transmission electron microscopy to determine the influence of the free surface on void formation. Single crystal molybdenum discs were bombarded at 1000^{0} +- 25°C with 5 MeV Ni^{++} ions at surface dose rates of 3×10^{-4}, 1.8×10^{-3}, and 8×10^{-3} dpa/sec. The void size and density were determined as a function of depth below the bombarded surfaces. Voids were observed within 100 A of the bombarded surfaces and no significant indications of surface-related effects were observed. The variations in void size and density are discussed in terms of the total dose and dose rate at the various regions of examination and the results compared with existing ion bombardment and neutron irradiation data. (auth)

4368 (BNWL-SA—5400) **Ion bombardment simulation: a review related to fusion radiation damage.** Brimhall, J.L. (Battelle Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)-1830. 22p. (CONF-751062—29). Dep. NTIS $4.50.

From 10. annual meeting of the Geoscience Information Society; Salt Lake City, Utah, USA (21 Oct 1975).

Prime emphasis is given to reviewing the ion bombardment data on the refractory metals molybdenum, niobium and vanadium which have been proposed for use in advanced fusion devices. The temperature and dose dependence of the void parameters are correlated among these metals. The effect of helium and hydrogen gas on the void parameters is also included. The similarities and differences of the response of these materials to high dose, high temperature radiation damage are evaluated. Comparisons are made with results obtained from stainless steel and nickel base alloys. The ion bombardment data is then compared and correlated, as far as possible, with existing neutron data on the refractory metals. The theoretically calculated damage state produced by neutrons and ions is also briefly discussed and compared to experimental data wherever possible. The advantages and limitations of ion simulation in relation to fusion radiation damage are finally summarized. (auth)

4369 (CONF-750905—21) **Surface erosion of fusion reactor components due to radiation blistering and neutron sputtering.** Das, S.K.; Kaminsky, M. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 5p. Dep. NTIS $4.00.

From 7. European conference on controlled fusion and plasma physics; Lausanne, Switzerland (1 Sep 1975).

Radiation blistering and neutron sputtering can lead to the surface erosion of fusion reactor components exposed to plasma radiations. Recent studies of methods to reduce the surface erosion caused by these processes are discussed. (auth)

4370 (CONF-751039—1) **Gas bubbles in stress and thermal gradients.** Hall, B.O.; Wiedersich, H. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 23p. Dep. NTIS $4.25.

From International conference on radiation effects and tritium technology for fusion reactors; Oak Ridge, Tennessee, USA (1 Oct 1975).

Inert gases introduced into the first wall of a CTR by injection from the plasma and by (n,α) reactions occurring in the wall tend to precipitate into bubbles. The forces on gas bubbles that arise from various sources of stress have been explored. The bubble is approximated by a center of dilatation in an elastically isotropic solid. The first-order size interactions of bubbles with elastic fields due to the presence of the surface, dislocations, other gas bubbles, and thermal gradients have been evaluated. The relative magnitudes of the resultant driving forces on the bubbles have been calculated, and their effect on bubble diffusion is discussed. The region of validity of the center of dilatation approximation has been examined. The effects due to a finite bubble size are described. (auth)

4371 (DP-MS—75-43) **Radiation damage by ^{252}Cf fission fragments and alpha particles.** Gould, T.H. Jr.; McDonell, W.R. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). 1975. Contract AT(07-2)-1. 20p. (CONF-751026—18). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Rates of atom displacement and helium injection in materials exposed to ^{252}Cf fission fragments and alpha particles were calculated to establish the potential for use of ^{252}Cf sources for radiation damage studies. Maximum displacement rates of about 10^{-6} dpa/sec at the surface of typical targets exposed to a ^{252}Cf fission fragment source were comparable to those experienced by materials in a fast breeder reactor or in a controlled thermonuclear reactor (CTR) first wall, though much lower than the displacement rates achieved using particle accelerators. Helium was concurrently accumulated at a rate of 3×10^{-4} atom ppM/sec at the target surface, yielding a He/displacement ratio 10^{3} times that produced in the fast breeder reactor materials, but only about 20 times that produced in the CTR materials. These comparisons suggest that ^{252}Cf fission fragment sources may find useful applications in studies of effects of high-He content on radiation damage in CTR materials. (auth)

4372 (HEDL-SA—947) **Analysis of irradiation with time-dependent sources.** Schiffgens, J.O.; Graves, N.J.; Doran, D.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Sep 1975. Contract E(45-1)-2170. 42p. (CONF-751026—16). Dep. NTIS $5.25.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Various CTR designs call for pulsed operation with cycle lengths ranging from several seconds to about a hundred minutes, and pulse lengths ranging from nanoseconds to the neighborhood of ninety minutes. Fluctuations in temperature, stress, and damage rate resulting from pulsed reactor operation are expected to significantly affect component life. This paper describes the first phase of an analysis of effects resulting from damage rate fluctuations. Procedures for modeling cluster growth are discussed and the results of calculations of the net growth of gas containing voids during an irradiation cycle are presented. These calculations show that the pulse parameters chosen for reactors and irradiation sources can dramatically alter swelling, and most probably other irradiation effects. For example, if the irradiation pulse length is less than about 10 μ sec and the interval between pulses is greater than about ten vacancy mean lives, no void growth is possible in stainless steel regardless of temperature, dislocation density and pulse amplitude (instantaneous displacement rate) provided no voids form in displacement cascades which are large enough to survive the time between pulses. (auth)

4373 (HEDL-SA—948) **Application of damagae functions to CTR component fluence limit predictions.** Simons, R.L.; Doran, D.G. (Hanford Engineering Development Lab., Richland, Wash. (USA)). 1975. Contract E(45-1)-2170. 24p. (CONF-751026—22). Dep. NTIS $4.25.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Material behavior observed under irradiation conditions in test reactors is not always directly applicable to the design of reactor components such as CTR first wall because of differences in the damage effectiveness of test reactor and service spectra. The interpolation and, under some conditions, extrapolation of material property change data from test conditions to different neutron spectra in service conditions can be accomplished using semi-empirical damage functions. The derivation and application of damage functions to CTR conditions is reviewed. Since limited amounts of data are available for applications to CTR design spectra, considerable attention is placed on the effectiveness of various available and proposed neutron sources in determining a damage function and subsequent fluence limit prediction. Neutron sources included in this study were EBR-II, HIFR, LAMPF (Be and Cu targets), high energy deuterons incident on Be (D-Be), and 14 MeV neutrons (D-T). (auth)

4374 (HEDL-SA—951) **Dimensional stability of stainless steel as affected by compositional transmutations.** Bates, J.F.; Schiffgens, J.O.; Paxton, M.M. (Hanford Engineering Development Lab., Richland, Wash. (USA)). Aug 1975. Contract E(45-1)-217. 17p. (CONF-751026—17). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Some effects of transmutations of Mn, Ni, Ti and V in 316 stainless steel which would be expected in a first wall CTR application were evaluated. Based on the available data and relevant investigations, it is concluded that little or no deleterious effects on the recrystallization temperature or 1400°F tensile properties will be experienced by the steel as a result of these transmutations. Small lattice strains (less than 0.1 percent for 30 years' residence time) will be experienced due to changes in Mn and Ni content. In conclusion, the results show that a 316 stainless steel first wall of a controlled thermonuclear reactor could operate up to 30 years with no serious change in tensile properties or recrystallization temperature, although small changes in dimensions due to lattice strain would occur. If 20 percent cold worked 316 is used, the material would be thus swelling and limited in its use. No significant change in the swelling behavior of the original alloy would be expected from the solid transmutations. (auth)

4375 (HEDL-TME—75-90) **Controlled thermonuclear research. Quarterly report, April—June 1975.** Doran, D.G.; Yoshikawa, H.H. (comps.). (Hanford Engineering Development Lab., Richland, Wash. (USA)). Jul 1975. Contract AT(45-1)-2170. 41p. Dep. NTIS $5.45.

The initial results are given of a study of the effects of pulsing of a neutron source on the nucleation of defect microstructures. It is shown that significant throttling of nucleation rates may occur in irradiation systems of interest. Previous work concerned with the influence of cascade-produced vacancy clusters on nucleation of voids has been extended to include the effect of these clusters on the vacancy supersaturation. If the vacancy-cluster binding energy is sufficiently high, the previously found nucleation enhancement can give way to a diminution due to the decreased vacancy supersaturation. New displacement damage cross sections based on ENDF/B-IV data are given for Al, Ni, Cu, Zr, W, and Pb. Preliminary attempts to estimate displacement cross sections for energetic protons in nickel suggest Rutherford-based values are low by perhaps 40 percent at 20 MeV and 60 percent at 30 MeV. A brief description is given of irradiations performed at LLL with the RTNS to measure helium production cross sections at 14 MeV. (auth)

4376 (LA-UR—75-1566) **Linear theta pinch as a 14-MeV neutron source.** Ellis, W.R. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-Eng-36. 6p. (CONF-750944—2). Dep. NTIS $4.00.

From 3. topical conference on pulsed high beta plasmas; Abingdon, Oxfordshire, UK (9 Sep 1975).

A linear theta pinch is considered as the neutron source in a Fusion Engineering Research Facility (FERF). The device is optimized parametrically for maximum 14-MeV neutron flux through a test sample located between the discharge tube and the compression coil wall. A flux of approximately 10^{14}n/cm^2/s can be achieved through a test-sample volume of 6.5 liters in a device 1.7 m long with a 150-kG magnetic field, 2:1 mirrors (300 kG) at the ends, a discharge frequency of 1.9 kHz, and a rotating-machinery power supply. (auth)

4377 (LA-UR—75-1846) **Effects of ionizing radiation of electrical properites of refractory insulators.** van Lint, V.A.J.; Bunch, J.M. (Los Alamos Scientific Lab., N.Mex. (USA)). 1975. Contract W-7405-ENG-36. 18p. (CONF-751026—24). Dep. NTIS $4.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The Los Alamos Reference Theta Pinch Reactor (RTPR) requires on the first wall an electrical insulator which will withstand transient high voltage at high temperature 10 sec after severe neutron and ionizing irradiation. Few measurements of electrical parameters for heavily disordered refractory insulators have been reported; estimates are made as to whether breakdown strength or conductivity will be degraded by the irradiation. The approach treats separately short-term ionization effects (free and trapped electrons and holes) and long-term gross damage effects (transmutation products and various lattice defects). The following processes could produce unacceptable conduction across the first wall insulator: (a) delayed electronic conductivity 10 sec after the prompt ionization by bremsstrahlung; (b) prompt electronic conductivity from delayed ionization; (c) electronic breakdown; (d) electronic or ionic conductivity due to thermal motion in the disordered material, possibly leading to thermal breakdown. Worst-case calculations based on lower limits to recombination coefficients limit process (a) to sigma much less than 5×10^{-14} mho/cm. Data on ionization-induced conductivity in insulators predict for process (b) sigma much less than 10^{-6} mho/cm. Electronic breakdown generally occurs at fields well above the 10^5 V/cm required for RTPR. Thermal breakdown is negligible due to the short voltage pulse. Ionic and electronic conduction must be studied theoretically and experimentally in the type of highly disordered materials that result from neutron irradiation of the first wall. (auth)

4378 (SAND—75-5393) **Atomic displacement distributions for light energetic atoms incident on heavy atom targets.** Brice, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 11p. (CONF-751006—7). Dep. NTIS $4.00.

From International conference on radiation damage in metals; Gatlinburg, Tennessee, USA (5 Oct 1975).

The depth distributions of atomic displacements produced by 4 to 100 keV H, D, and He ions incident on Cr, Mo, and W targets have been calculated using a sharp displacement threshold, E/sub d/ = 35 eV, and a previously described calculational procedure. These displacement depth distributions have been compared with the depth distributions of energy deposited into atomic processes to determine if a proportionality (modified Kinchin—Pease relationship) can be established. Such a relationship does exist for He ions and D ions incident on these metals at energies above 4 keV and 20 keV, respectively. For H ions the two distributions have significantly different shapes at all incident energies considered. (auth)

4379 (SAND—75-5437) **Techniques for studying hydrogen and helium isotopes in materials: ion backscattering and nuclear microanalysis.** Langley, R.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 17p. (CONF-751026—10). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The techniques of ion backscattering and nuclear microanalysis as tools for studying hydrogen and helium isotopes in solid materials are discussed and compared. The advantages, disadvantages and limitations of each of these techniques are explored. Experimental results obtained using the two techniques are analyzed to obtain information on concentration-versus-depth profiles for these light atoms in heavy atom substrates. Measurements of the elastic scattering cross section for the ^{3}H(p,p)^{3}H interaction are also discussed. (auth)

4380 (SAND—75-5520) **Sputtering of ErD_2: experiment and theory.** EerNisse, E.P.; Brice, D.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 17p. (CONF-750965—2). Dep. NTIS $4.00.

From International conference on atomic collisions in solids; Amsterdam, Netherlands (22 Sep 1975).

Experimental measurements were made of the sputtering yield of ErD_2 targets bombarded by D and A ions in the energy range 50-400 keV. A semiempirical sputtering theory is presented that relates sputtering to the energy deposited into atomic collisions beneath the target surface as well as at the surface. The theory accurately predicts the sputtering yields for both D and A bombardment. Additional calculated sputtering yields for ErD_2 targets are presented which should allow extrapolation to any ion in the range of Z = 1 to Z = 36 with an accuracy better than 50 percent. (auth)

4381 (SAND—75-5802) **PROTO-II: a short pulse water insulated accelerator.** Martin, T.H.; VanDevender, J.P.; Johnson, D.L.; McDaniel, D.H.; Aker, M. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 29p. (CONF-751108—7). Dep. NTIS $5.00.

From 1. international topical conference on electron beam research and technology; Albuquerque, New Mexico, USA (3 Nov 1975).

A new accelerator, designated Proto-II, is presently under construction at Sandia Laboratories. Proto-II will have a nominal output of 100 kJ into a two-sided diode at a voltage of 1.5 MV and a total current of over 6 MA for 24 ns. This accelerator will be utilized for electron beam fusion experiments and for pulsed power and developmental studies leading to a proposed further factor of five scale-up in power. The design of Proto-II is based upon recent water switching developments and represents a 10-fold extrapolation of those results. Initial testing of Proto-II is scheduled to begin in 1976. Proto-II power flow starts with eight Marx generators which charge 16 water-insulated storage capacitors. Eight triggered, 3 MV, SF_6 gas-insulated switches next transfer the energy through oil-water interfaces into the first stage of 16 parallel lines. Next, the 16 first stages transfer their energy into the pulse forming lines and fast switching sections.The energy is then delivered to two converging, back-to-back, disk-shaped transmission line. Two back-to-back diodes then form the electron beams which are focused onto a common anode. (auth)

4382 (UCRL—51872) **Design of a repetitively pulsed megajoule dense-plasma focus.** Zucker, O.; Bostick, W.; Gullickson, R.; Long, J.; Luce, J.; Sahlin, H. (California Univ., Livermore

(USA). Lawrence Livermore Lab.). 1 Aug 1975. Contract W-7405-Engn48. 58p. Dep. NTIS $5.45.

This report describes a 1 pulse per second, dense-plasma-focus (DPF) materials-testing device capable of delivering a minimum of 10^{15} neutrons per pulse. Moderate scaling up from existing designs is shown to be sufficient to provide 2 x 10^{13} neutrons/ cm^2. s to a suitable target. The average power consumption, which has become a major issue due to the energy crisis, is analyzed with respect to other plasma devices and is shown to be highly favorable. Also discussed is a novel approach to capacitor-bank and switch design with respect to repetitive-pulse operation. (auth)

4383 (UCRL—76761) **Analyses and hydrogen-isotope-transport calculations of current and future designs of the LLL rotating-target neutron source.** Steward, S.A.; Nickerson, R.; Booth, R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 8 Sep 1975. 19p. (CONF-751026—9). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

Analyses of the present titanium-tritide RTNS targets are presented. These results include the hydrogen-isotope content of new and used targets, metallography, scanning electron microscopy, and hydrogen-isotope-diffusion calculations using a heat-flow finite-difference computer code. These latter calculations indicate that a combination of long target life and high neutron output is optimized when the rate of hydrogen isotope evolution from the target balances the deposition rate from the beam. Auger spectra show that carbon and oxygen species are present in the bulk and on the surface. (auth)

4384 (UCRL—76765) **Helium generation in copper by 14.8-MeV neutrons.** Holt, J.B.; Hosmer, D.W.; Van Konynenburg, R.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Sep 1975. Contract W-7405-Eng-48. 11p. (CONF-751026—7). Dep. NTIS $4.00.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

High purity copper foils were irradiated with 14.8-MeV neutrons from the rotating target neutron source facility at LLL. The average energy of the neutrons was 14.75 +- 0.1 MeV, and the average fluence was 7.0 x 10^{16} n/cm^2. After irradiation each foil was heated to the melting point and the released helium was measured by a mass spectrometer of special design. Isochronal heating was carried out on several samples to establish the type and temperature of maximum release. Calculated cross sections from the literature for the (eta,α) and (eta,eta'α) nuclear reactions were used, and the predicted amount of helium was consistently about 0.5 of that actually measured. Because there is very little data on helium generation in metals irradiated with high energy neutrons, these results are important and will be related to potential CTR materials. (auth)

4385 (UCRL—77240) **Vacuum system for the Livermore intense neutron source.** Hanson, C.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Nov 1975. 5p. (CONF-751125—33). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

To fulfill the need for intense 14-MeV neutron sources for controlled thermonuclear reactor material damage studies, several accelerators will be built at the Lawrence Livermore Laboratory. A high-capacity vacuum system will be required to handle the large deuterium gas load needed to produce the beam current. Outgassing of tritium from the target necessitates special handling of the exhaust from the vacuum pumps. A vacuum system utilizing turbomolecular pumps was selected after comparing its performance with mercury vapor diffusion and titanium bulk sublimation/ion pumps. (auth)

4386 (UCRL—77263) **Analysis of the steady-state operation of vacuum systems for fusion machines.** Roose, T.R.; Hoffman, M.A.; Carlson, G.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Nov 1975. Contract W-7405-Eng-48. 8p. (CONF-751125—30). Dep. NTIS $4.50.

From IEEE 6. symposium on engineering problems of fusion research; San Diego, California, USA (17 Nov 1975).

A computer code named GASBAL was written to calculate the steady-state vacuum system performance of multi-chamber mirror machines as well as rather complex conventional multichamber vacuum systems. Application of the code, with some modifications, to the quasi-steady tokamak operating period should also be possible. Basically, GASBAL analyzes free molecular gas flow in a system consisting of a central chamber (the plasma chamber) connected by conductances to an arbitrary number of one- or two-chamber peripheral tanks. Each of the peripheral tanks may have vacuum pumping capability (pumping speed), sources of cold gas, and sources of energetic atoms. The central chamber may have actual vacuum pumping capability, as well as a plasma capable of ionizing injected atoms and impinging gas molecules and "pumping" them to a peripheral chamber. The GASBAL code was used in the preliminary design of a large mirror machine experiment—LLL's MX. (auth)

4387 (UCRL—77357) **DT fusion neutron radiation strengthening of copper and niobium.** Mitchell, J.B.; Van Konynenburg, R.A.; Echer, C.J.; Parkin, D.M. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 29 Sep 1975. 62p. (CONF-751026—20). Dep. NTIS $5.50.

From International conference on radiation effects and tritium technology for fusion reactors; Gatlinburg, Tennessee, USA (1 Oct 1975).

The initial results of a comparative study of the radiation strengthening and damage structures produced in Cu and Nb by D-T fusion and fission reactor neutrons are described. The radiation strengthening produced by a given fluence of fusion neutrons above about 10^{17} n/cm^2 is equal to that produced by a fluence of fission reactor neutrons (E greater than 0.1 MeV) ten times as great. This difference is about twice as large as would be expected if the strengthening scaled with damage energy or dpa. Initial transmission electron microscopy observations of the damage structures in fusion and fission reactor neutron irradiated copper indicate that the same type of primary structural defects, vacancy and interstitial point defect clusters and small dislocation loops with a/3 (111) and a/2 (110) Burgers vectors, are produced in both cases. The difference in the radiation strengthening produced by fusion and fission reactor neutrons in Cu appears to result from a substantially greater rate of accumulation of damage, in the form of point defect clusters, during irradiation with fusion neutrons than during irradiation with fission reactor neutrons plus a significant difference in the size and spatial distributions of the damage clusters. (auth)

4388 (ANL-Trans—993) **Damage to materials during irradiation with a particle current with a wide energy spectrum.** Gusev, V.M.; Guseva, M.I.; Krasulin, Yu.L.; Martinenko, Yu.V. (Gosudarstvennyj Komitet po Ispol'zovaniyu Atomnoj Ehnergii SSSR, Moscow. Inst. Atomnoj Ehnergii). 1975. Translation of IAE—2529. 14p. Dep. NTIS $4.50.

Blistering under the effects of accelerated He ions depends substantially on the distribution according to depth (profile) of interstitial ions and defects created with ion irradiation. In this work, profiles are calculated for interstitial ions and defects for the ion energy spectrum expected in thermonuclear reactors operating with a D-T-reaction. Recommendations are made for experimental modeling of the effects of ions with a wide spectrum of energies at the target. (auth)

4389 **Tokamak-divertor experiment in the dc Octopole.** Prater, R.; Freeman, R.L.; Hamada, Y.; Moeller, C.; Ohkawa, T.; Tamano, T. (General Atomic Co., San Diego, CA). pp 291-296 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. I. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.I); CONF-741105—P1.

An Ohmic current has been inductively driven in the dc Octopole. The resulting flux configuration resembles that of a tokamak with axisymmetric divertors. The peak current is 4 kA in a toroidal field of 450 G, the density on the axis is 4 x 10^{11} cm^{-3} and the conductivity electron temperature is 27 eV. Because the plasma energy density is low, magnetic probes can be inserted into the plasma for measurements of the plasma current distribution. Magnetic probe traces that are quiet and reproducible at all positions indicate that the plasma has obtained a stable equilibrium. The initial stage of the discharge is very sensitive to error magnetic fields. Plasma current grows until a current disruptive instability occurs, which reduces the peak current density by 40 percent. At the time of the instability the safety factor q at the axis is estimated to be q(0) approximately 0.8, while the $q = 1$ surface is located at the edge of current distribution. The effect of the instability is to redistribute current density from the center of the distribution to the wings. The disruptive instability is characterized by mode numbers $m = 0$, $n = 0$, but it is usually preceded by amplitude saturated fluctuations with $m = 2$, $n = 1$ that are peaked on the $q = 2$ surface. (auth)

4390 **Radiation damage by neutrons to materials in DT fusion reactors.** Kulcinski, G.L. (Univ. of Wisconsin, Madison). pp 251-273 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

A review of the effects of DT neutron damage in fusion reactor structural components and magnets is given. It is shown that the displacement rates in fusion systems are about equal to or less than those of present-day fission reactor facilities but gas production rates are one to two orders of magnitude higher. The effect of neutrons on mechanical properties such as yield strength, ductility, and creep is briefly reviewed and it is noted that very little, if any, direct data exist for 14-MeV-neutron- irradiated metals. Resistivity increases in magnet-stabilizing metals and the reduction in critical properties of superconductors is shown to be minimal and subject to reduction by several design options. The level and decay of induced radioactivity is explored for various metals and levels of greater than or equal to 1 Ci per thermal watt are easily achieved at shutdown. The decay of afterheat, from shutdown values of 0.5 to 1 percent of the operating power, is shown to be a function of materials choice and V and Al appear to offer some distinct advantages. Finally, a possible method of solving radiation damage problems is discussed. (auth)

4391 Silicon carbide and graphite materials for fusion reactors. Hopkins, G.R. (General Atomic Co., San Diego, CA). pp 275-285 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

The utilization of low-atomic-number materials for first-wall and blanket structural materials for fusion reactors and devices is proposed. The low-atomic-number (Z) materials are important to consider for minimizing radiation losses from plasma impurities (the losses may have a Z^6-dependence) and could be advantageous in present-day confinement devices as well as fusion power reactors. Silicon carbide, carbon materials, and mixtures appear as prime candidates. Advantages accruable in a fusion power reactor are 1) very low induced radioactivities for reduction of waste disposal and operational problems, 2) high-temperature operation (greater than 1000°C) for high efficiency and low waste heat, and 3) abundant and inexpensive raw-material supply. Material properties appear reasonably well suited for fusion-reactor application and a technology base is available from a High-Temperature Gas-Cooled Reactor (fission) as well as many other applications. Significant problem areas for further study are the effects of transmutation products from (n, α) and (n, p) reactions in the materials, and design and fabrication problems for relatively large, high-integrity structures with these ceramic, non-ductile materials. (auth)

4392 Plasma contamination and wall erosion in controlled thermonuclear fusion devices and reactors. Kaminsky, M.S. (Argonne National Lab., IL). pp 287-299 of In Plasma physics and controlled nuclear fusion research, 1974. Vol. II. Vienna; International Atomic Energy Agency (1975).

From 5. conference on plasma physics and controlled nuclear fusion research; Tokyo, Japan (11 Nov 1974).

See STI/PUB—381(Vol.2); CONF-741105—P2.

During the operation of thermonuclear devices and reactors, the surfaces of such major components as container walls, beam limiters, diverter walls, and beam-dump walls of the injector region will be exposed both to the primary plasma radiations and to secondary radiations from (n, γ), (n,p), (n, α), and other nuclear reactions and from various secondary particle- and photon-emission phenomena induced by the primary radiation. Such energetic radiations striking the surfaces of components of fusion devices and reactors can cause a variety of surface phenomena and thereby (a) the release of major quantities of gas which will contaminate the plasma, and (b) the damage and erosion of the bombarded wall. A summary of recent experimental results on plasma contamination and wall erosion due to radiation blistering and the release of particulate matter from solids under irradiations induced by 14-MeV neutrons will be presented. (auth)

GENERAL AND MISCELLANEOUS

4393 (ORNL-RUS—6) **Estimating direct regional employment in export base recreation: the Great Smoky Mountains National Park.** Kerley, C.R. (Oak Ridge National Lab., Tenn. (USA)). Aug 1975. Contract W-7405-eng-26. 24p. Dep. NTIS $4.25.

The report presents a simple framework for measuring and projecting the direct regional impacts of recreation activity associated with a national park. The study included a potential (gravity) analysis of visitor interaction and a regression model that related county level retail service activity to population and income growth in a multiregional attractiveness area. The gravity analysis results indicated a time distance exponent of 0.70 for 1970 visits to the Great Smoky Mountains National Park. In a forecast application in BEA 50 (Bureau of Economic Analysis Area 50), the estimated pool cross-section linear regression model indicated that 2700 retail service employees in 1970 and 4300 in 1980 could be considered export recreation employment. (auth)

MANAGEMENT

4394 Summer workshops for high-school science teachers. Young, H.H. (Energy Research and Development Administration, Washington, DC); Kohl, J. *Nucl. Technol.*; **27**: No. 1, 148-153(Sep 1975).

A total of 52 summer workshops attended by over 1700 high-school science teachers have been given by 27 universities in the period of 1971 to 1974. These workshops are funded by ERDA to provide factual material through educational channels so that the public could obtain an informed perspective of the role of nuclear energy as an electrical power source. The workshops have included lectures, panel discussions, laboratories, and field trips, and have emphasized providing teachers with materials for use in their classrooms. Actual use of workshop material has been monitored through workshop reports, meetings, and visits. Participants have used their workshop experience for classroom presentations, talks to the public, and for assembly programs. The material developed and the experience of presenting it has proved valuable for the nuclear engineering faculty members giving the workshops. They have used their experience in other courses, for public lectures, and for other workshops. And they have gained personal experience in methods of dealing with the nuclear power controversy. A review of these workshops indicates that they offer at a reasonable cost a productive method of presenting factual information on the various solutions to the complex electrical generation problem. (auth)

MATHEMATICS AND COMPUTERS

4395 (AECL—4663) **Conversion of Digital Equipment Corporation PDP-8 FORTRAN (8K) to interruptable operation.** Bridges, H.J. (Atomic Energy of Canada Ltd., Pinawa, Manitoba. Whiteshell Nuclear Research Establishment). Jun 1975. 54p. Dep. NTIS (US Sales Only) $5.50. AECL $1.50.

The input--output software suggested by Digital Equipment Corporation for use with PDP-8 (8K) FORTRAN does not make use of the interrupt hardware. This report describes the changes made to this software system and to the program loader to make use of the interrupt hardware. Some restrictions on the use of the new system are described. (auth)

4396 (AECL—5182) **FAUTRAN: a fault tree analyser.** Wong, P.Y. (Atomic Energy of Canada Ltd., Chalk River, Ontario. Chalk River Nuclear Labs.). Aug 1975. 43p. Dep. NTIS (US Sales Only) $5.00. AECL $1.50.

FAUTRAN is a reliability code which calculates failure probability of a system given in the form of a fault tree. In FAUTRAN, system components are represented by prime numbers such that unwanted component combinations can be efficiently eliminated for probability calculation. The program accepts fault trees containing AND and OR gates, with or without common components. The analysis of FAUTRAN is presented. A description of the program structure is also included. (1 figure, 4 tables) (auth)

4397 (ANL—75-44) **Guide to TSO speakeasy.** Coehn, S.; Fink, J.; Serduke, F.J.D.; Kriloff, H.Z. (Argonne National Lab., Ill. (USA)). Oct 1975. Contract W-31-109-Eng-38. 71p. Dep. NTIS $5.45.

Speakeasy is a computer programing system that is powerful yet easily learned. The book is intended as an introductory guide to this system. It assumes that the reader is a complete novice, both with regard to Speakeasy and to the use of TSO. This book is divided into several sections in which the processor is used in a desk-calculator mode to demonstrate its capabilities for matrix operations, for calculations in calculus, and for operations involving logical and relational tests. The program mode and the use of available teaching aids are also described. (3 figures) (auth)

4398 (BNWL-SA—5570) **Directions of computing in support of laboratory research.** Mahan, R.E.; Erickson, M.D. (Battelle

Pacific Northwest Labs., Richland, Wash. (USA)). 1975. Contract E(45-1)h1830. 16p. (CONF-751061—1). Dep. NTIS $4.50.

From Conference on computing directions; Chico, California, USA (11 Oct 1975).

Prospective trends in computing as applied to the problems faced by a large multi-purpose research laboratory are surveyed. (2 figures) (auth)

4399 (CONF-750482—5) **Panel presentation: basic suggestions on system development for the new user.** Davies, R.C. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 2p. Dep. NTIS $4.00.

From DECUS symposium; Miami, Florida, USA (15 Apr 1975).

The purpose of this panel discussion is to give the newcomer some specific suggestions to solve his problem and to entertain his questions generally. Examples of an interrupt handler, a command structure, cross-assemblers, and other basic ideas which have been helpful to the panelists are presented. Techniques used in the development of compilers and of a major software system are discussed. (auth)

4400 (CONF-750570—1) **Developments of architecture for real-time data systems.** Heath, R.L.; Myers, W.R. (Aerojet Nuclear Co., Idaho Falls, Idaho (USA). Idaho National Engineering Lab.). 1975. 6p. Dep. NTIS $4.50.

From 2. ispra nuclear electronics symposium; Milan, Italy (20 May 1975).

Real-time data systems typically operate at two levels: a fast-response instrument-oriented level for data acquisition and control, and a slow human-oriented level for interaction and computation. Traditional minicomputer data systems support real-time applications by implementation of background/foreground software. Recent developments in computer technology including microprocessors enable the functional organization of hardware in distributed or hierarchical form to provide new system structures for real-time requirements. Examples of systems with distributed architecture are discussed in detail. (6 figures, 4 tables) (auth)

4401 (CONF-750864—1) **Precision of fixed-point arithmetic operations in PL/I.** Dritz, K.W. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 10p. Dep. NTIS $4.00.

From 45. SHARE conference; New York, New York, USA (18 Aug 1975).

The concept of fixed-point data in PL/I is reviewed and the fixed-point precision rules for the familiar arithmetic operations are derived. The analysis should help dispel some of the confusion experienced by programmers, and prepare the reader for deeper study of the problem. (RWR)

4402 (CONF-751014—6) **Modularized package of dual algorithms for solving constrained nonlinear programming problems.** Minkoff, M. (Argonne National Lab., Ill. (USA)). 1975. Contract W-31-109-Eng-38. 5p. Dep. NTIS $4.50.

From ACM Association of Computing Machinery; Minneapolis, Minnesota, USA (20 Oct 1975).

A package of algorithms for numerical experimentation with constrained optimization methods is described. This package is addressed to dual methods and is modularized to permit experiments with a particular module (such as a penalty function module) without changing any of the other modules. Thus reliable comparisons can be made without questioning differences in implementations of the remaining portions of a constrained algorithm. The feasibility of modularization as well as advantages and disadvantages for dual algorithms are discussed. Some numerical results are also presented. (1 figure, 1 table) (auth)

4403 (CONF-751113—3) **Random matrices and random difference equations.** Uppuluri, V.R.R. (Union Carbide Corp., Oak Ridge, Tenn. (USA). Nuclear Div.). 1975. 24p. Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

Mathematical models leading to products of random matrices and random difference equations are discussed. A one-compartment model with random behavior is introduced, and it is shown how the average concentration in the discrete time model converges to the exponential function. This is of relevance to understanding how radioactivity gets trapped in bone structure in blood—bone systems. The ideas are then generalized to two-compartment models and mammillary systems, where products of random matrices appear in a natural way. The appearance of products of random matrices in applications in demography and control theory is considered. Then random sequences motivated from the following problems are studied: constant pulsing and random decay models, random pulsing and constant decay models, and random pulsing and random decay models. (RWR)

4404 (COO—2383-0025) **Automatic integration of the heat equation.** Ostrar, M.H. (Illinois Univ., Urbana (USA). Dept. of Computer Science). Oct 1975. Contract AT(11-1)-2383. 31p. (UIUCDCS-R—75-754). Dep. NTIS $5.00.

Thesis.

A scheme for automatically integrating the heat equation is discussed. A program based on this scheme is explained, and the results of integrating the heat equation for a number of different initial conditions are presented and interpreted. (4 figures, 7 tables) (auth)

4405 (DEMO—75/5) **Time domain synthesis of digital Laguerre filters.** King, R.E.; Paraskevopoulos, P.N. (Democritus Nuclear Research Center, Athens (Greece)). Jun 1975. 38p. Dep. NTIS (US Sales Only) $5.00.

The essential theory and a time domain synthesis procedure for a class of digital filters which are the discrete analogs of the classical continuous Laguerre filters are presented. The resultant filters are nonrecursive and yet have an infinite impulse response. These filters possess a transversal structure which may be suitably truncated. An algorithm for minimizing truncation errors and a computer-aided design procedure are presented. Two typical examples are given which illustrate the synthesis procedure. (10 figures) (auth)

4406 (DEMO—75/9) **Kronecker product approach to pole shifting by output feedback.** Paraskevopoulos, P.N.; King, R.E. (Democritus Nuclear Research Center, Athens (Greece)). Aug 1975. 17p. Dep. NTIS (US Sales Only) $4.00.

A method is presented which reduces the problem of determining the output feedback modal (eigenvalue or pole) control matrix K of a system to an explicit linear set of equations in the elements of K through the use of the Kronecker product. This set of equations is then partitioned into two subsets, one that constitutes the sufficient conditions for the existence of a solution and, provided this is consistent, a second subset that yields the desired modal control matrix. (auth)

4407 (HMI-B—161) **A FORTRAN-compatible program package for the control of CAMAC systems by a PDP-11 (CA11-A/DEC, Type 1533A/BORER).** Lengauer, C. (Hahn-Meitner-Institut fuer Kernforschung Berlin G.m.b.H. (F.R. Germany). Sektor Strahlenchemie). 1975. 116p. (In German). INIS.

With figs. and tabs.; 6 refs.

The described software serves for the control of CAMAC systems by PDP-11 computer with one DEC CA11-A branch-driver up to ten BORER-type 1533A single crate controllers under the operating system DOS V08. The software consists of three parts: 1) a subroutine library for programming in FORTRAN, 2) a macro library for programming in Assembler (for time-critical problems), 3) a loadable CAMAC driver for controlling the system by input of single CAMAC commands at the terminal. Programs which apply the first two parts can be written independently of the CAMAC controller used at run time. (auth)

4408 (JINR—P11-8980) **Listing of EBCDIC texts from 9-track magnetic tape EC-5012 on lineprinter-128 of BESM-4 computer.** Puzynina, T.P.; Danilova, K.N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1975. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The description of a program package for the listing of EBCDIC texts from 9-track magnetic tape EC-5012 on the lineprinter-128 of the BESM-4 computer is presented. It allows one to get data from the tape in a visible form and to use it in computer systems like the one at JINR. (1 table) (auth)

4409 (KFK—2178) **Specification of a CAMAC single crate controller with DMA option for the PDP-11 Unibus.** Barthel, H.; Heep, W.; Ottes, J.G. (Kernforschungszentrum Karlsruhe (F.R. Germany). Abt. Datenverarbeitung und Instrumentierung). Aug 1975. 27p. Dep. NTIS (US Sales Only) $5.00.

A CAMAC Single Crate Controller with DMA option has been designed for use with PDP-11 computer family. The controller consists of two double width CAMAC modules: the I/O controller and the DMA controller. The I/O controller, occupying 6 Unibus word addresses, is responsible for command operation and data transfer between the computer and CAMAC modules by program control and for interrupt requests resulting from CAMAC LAM signals or from error conditions. If fast data transfer is required, the DMA controller, which is connected to the PDP-11 Unibus by assignment of 8 word addresses, has to be added. Operating in conjunction with the I/O controller, it may service up to 8 CAMAC modules simultaneously by performing LAM synchronized data transfer between CAMAC modules and computer memory by direct memory access via 8 data channels, every word transfer requiring a LAM request generated by the module to

be serviced. Within each data channel two operating modes are possible, either LIST mode or DMI mode. LIST mode means block transfer of data between one CAMAC address and a sequence of memory addresses. DMI mode assembles ADC data by incrementing the contents of addressed memory locations, thus enabling the computer to operate as a multi channel pulse height analyzer. (auth)

4410 (KFK-PDV—37) **KEDDC: a combined process computer program system for the design and application of DDC algorithms.** Unbehauen, H.; Schmid, C.; Boettiger, F.; Bauer, B.; Goehring, B. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Apr 1975. 86p. (In German). Dep. NTIS (US Sales Only) $7.50.

The new program system KEDDC described represents a combined process computer program system for the design and application of DDC algorithms. This program system allows the on-line design of industrial plants;and, based on that, the interactive design of optimal controllers; and finally the corresponding process control in DDC operation. The complex program system is built up in modular form. It consists of modules for system identification and design methods as well as higher DDC algorithms. By its comprehensive applicability and by the possibility for on-line modification, the system shows a high degree of flexibility. The program system can be easily implemented on other process computers because of its exceptional independence from the computer and the corresponding executive system using FORTRAN IV. The easy transferability of the system permits the implementation of the program modules in already existing or newly developed program systems for special applications. (22 figures) (auth)

4411 (KFK-PDV—39) **Testing of real-time software: analysis of user interviews and relevant literature.** Friesland, G.; Ovenhausen, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). May 1975. 95p. (In German). Dep. NTIS (US Sales Only) $7.75.

The situation in the area of testing real-time software is unsatisfactory. During the first phase of the project PROMOTE (prozeßorientiertes Modul- und Gesamttestsystem), an analysis of the present situation took place, results of which are summarized in the following study about some user interviews and an analysis of relevant literature. Twenty-two users (industry, software houses, hardware manufacturers, and institutes) were interviewed. Discussions were held about the reliability of real-time software with special interest in error avoidance, testing, and debugging. The main aims of the literature analysis were elaboration of standard terms, comparison of existing test methods and systems, and definition of boundaries of related areas. During the further steps of this project some means and techniques will be worked out to test real-time software systematically. (9 figures, 142 references) (auth)

4412 (KFK-PDV—40) **COPF: a set of program building blocks for real-time operating systems.** Ehrig, J.; Hahn, H.; Hotes, H.; Ibarra, A.; Skrebutis, E. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). May 1975. 100p. (In German). Dep. NTIS (US Sales Only) $8.00.

Depending on the application, operating systems for process control computers must often be changed, extended, or newly developed. To simplify these tasks a set of functional building blocks for constructing real-time operating systems was designed. The programs are organized in layers. The lowest layer consists of hardware-dependent basic functions; the middle layer, of functions that are neither hardware nor application dependent; and the upper layer, of application-specific functions. For the transfer of an operating system to another computer or the design of a system for a new application area, only part of the building blocks must be reprogramed. (30 figures) (auth)

4413 (KFK-PDV—44) **PSF: problem oriented language for transport systems, language-report.** Guenther, H.J.; Windauer, H.; Werum, W. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). May 1975. 212p. (In German). Dep. NTIS (US Sales Only) $13.75.

A computer-independent extensible language is described, which allows the user himself to program discrete event-driven processes with problem-oriented formulations. The development of the language took into account the safety and user-control of the programs. The computer-oriented statements (for example alternatives, loops, I/0) are the same as in PEARL. (5 figures) (auth)

4414 (KFK-PDV—49) **Hardware extended executive primitives for process control systems.** Nehmer, J.; Eggenberger, O. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Jun 1975. 101p. (In German). Dep. NTIS (US Sales Only) $8.25.

The report summarizes the results of a PDV project of the same name. It is divided into three parts, describing a structuring concept for real-time operating systems, a set of elementary opcrating system functions defined within the framework of the structure, and a related real-time software production system. (15 figures) (auth)

4415 (KFK-PDV—51) **DC 161 data controller for process automation application.** Didic, R. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Jul 1975. 46p. (In German). Dep. NTIS (US Sales Only) $5.00.

The DC 161 data controller is a programmable unit for process automation applications. It may be used as a central element to control plant equipment, control centers, communication systems, data concentrators, etc. Modular design permits assembly of cost-effective dedicated system configurations. Eight program levels, with eight hardware registers each, are provided. Direct program level switching is achieved by simply applying a switching request signal--this provides for a fast reaction to external events. A particular control interface allows internal central processor sequences to be controlled by external functional units. (6 figures) (auth)

4416 (KFK-PDV—52) **ACCS adaptable computer simulation system.** Kreis, P.; Heikel, H. (Gesellschaft fuer Kernforschung m.b.H., Karlsruhe (F.R. Germany)). Jul 1975. 83p. (In German). Dep. NTIS (US Sales Only) $5.50.

A simulation system whose principal area of application is process computer control and related fields is described. The major functional components treated are generator, simulator, and machine-description language. The first level of the machine-description language is described in special detail. The guiding idea in the system concept is to let the generator receive the particular characteristics of each machine to be simulated from the machine description, and construct an optimal simulator especially tailored to that machine. This method also provides an ideal solution environment for optimization problems which arise in technical and scientific work. The references are intended to be a subjective selection which should allow descriptions and comparisons. An attempt is made to demonstrate some of the problems of simulation by means of a concrete example. (3 figures, 4 tables) (auth)

4417 (LA—6003) **Bayesian reliability estimation: state of the art for the time-dependent case.** Waller, R.A.; Martz, H.F. Jr. (Los Alamos Scientific Lab., N.Mex. (USA)). Jun 1975. Contract W-7405-eng-36. 27p. Dep. NTIS $4.00.

The four types of reliability estimation techniques considered are nonparametric, classical, Bayes, and empirical Bayes. Point and interval estimators of reliability for exponential and Weibull data are considered for the time-dependent case in which the resulting estimators are functionally dependent on time. A set of exponential data is used for illustrating and comparing the different estimators. The assumptions underlying each type of estimation are given to provide an awareness of the costs and benefits associated with each technique. (14 figures, 4 tables) (auth)

4418 (LBL—4256) **Keyword access to a mass storage device at the record level.** Gey, F.; Mantei, M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). 12 Sep 1975. Contract W-7405-ENG-48. 18p. (CONF-750969—1). Dep. NTIS $4.00.

From International conference on very large data bases; Boston, Massachusetts, USA (22 Sep 1975).

A general software package was built to access individual data records stored on an IBM-1360 photo-digital mass storage device with a current on-line capacity of 50 billion characters (bytes) and an infinitely extensible off-line capacity. An existing data base management system was used to maintain the pointers to the data on the mass storage device and to store the controls for the data driven interactive code. Existing data dictionaries used for sequentially processing the data bases were stored in the DBMS and used to display individual data items within the retrieved records. Data retrieved from the mass storage device is displayed interactively or sent for further processing to various report generation and statistics packages. The system provides dial-up terminal retrieval capability for exceedingly large socio-economic and demographic data bases used by national and reginal planning agencies of the federal government. It was developed with three man-months of effort. (8 figures) (auth)

4419 (LBL—4607) **Overview of irate: interactive retrieval and text editor.** Leavitt, M.; Lederer, C.M. (California Univ., Berkeley (USA). Lawrence Berkeley Lab.). Sep 1975. Contract W-7405-ENG-48. 13p. Dep. NTIS $4.00.

A remote-terminal entry/editing system for complex technical text or structured data was developed at this laboratory. The system was tested in varied applications. IRATE hardware and software are discussed in brief, and its operational features are described. Some examples of IRATE-produced documents are shown, and potential future development of the system is discussed. (3 figures) (auth)

4420 (MATT—1178) **VIPER: a program for manipulating card-image files.** Price, W.G. Jr. (Princeton Univ., N.J. (USA). Plasma Physics Lab.). Nov 1975. Contract E(11-1)-3073. 32p. Dep. NTIS $4.00.

VIPER is a program designed to allow the easy manipulation of card-image files in IBM OS/360 systems. It combines, improves, and extends the features found in the earlier programs MANAGERY, EDITY, and CLICHE. VIPER may be applied to both sequential and partitioned files, which may be created, replaced, renamed, deleted, copied, edited, listed, or punched. Directory and compress operations can be applied to partitioned data sets. (auth)

4421 (MERC/SP—75/3) **Development and utilization of data acquisition, computing, and processing systems at the Morgantown Energy Research Center.** Shuck, L.Z.; Fasching, G.E.; Keech, T.W.; Johnson, K.G. (Energy Research and Development Administration, Morgantown, W.Va. (USA). Morgantown Energy Research Center). 17 Mar 1975. 38p. Dep. NTIS $4.00.

The Morgantown Energy Research Center (MERC) is engaged in a variety of research efforts to improve the extraction and conversion technology for fossil fuel energy resources. Large volumes and many different forms of experimental data are generated from the various research projects. To gather and process the data expeditiously, several small data acquisition and processing systems were developed. This document on MERC facilities and their use is intended to give information helpful in maintaining data and systems compatibility between in-house and outside cooperative research programs. The broad objectives for developing small computer systems and the arrangements for larger computer usage are discussed. (RWR)

4422 (NP—20578) **Programming Language I for the Varian PLCV.** Jacobs, J.J. (North Carolina Univ., Chapel Hill (USA). Dept. of Computer Science). 1971. 76p. Univ. of North Carolina, Chapel Hill.

Thesis.

Programing Language I for the Varian, PLCV, is a subset of PL/I. Its features include scaled fixed-point arithmetic, bit and character string processing, input/output facilities, and the capability to interface with Varian assembly-language programs. PLCV runs on the IBM System/360 and generates code in the form of relocatable binary object decks for Varian 620/i or 620/f computers. A linkage editor is also provided to relocate PLCV object decks and combine them with object decks which are output of GIF, a System/360 assembler for the Varian 620/i written by the Stanford Linear Accelerator Center. The powerful language capabilities of PLCV combined with the GIF assembler should provide the user with the ability to generate a wise range of Varian programs by using the IBM System/360 as the compiling medium. (auth)

4423 (ORO—3443-53) **Self-adaptive refinements in the finite element method.** Babuska, I.; Rheinboldt, W.; Mesztenyi, C. (Maryland Univ., College Park (USA)). May 1975. Contract AT(40-1)-3443. 46p. (NSF-OCA-GJ—35568X375). Dep. NTIS $5.50.

It is well-known theoretically that the accuracy of the finite element solution of a boundary value problem is very strongly influenced by the existence of singularities in the solution. For problems of this type it is rarely possible to design an a priori mesh which gives a solution with a prescribed error tolerance. Such a mesh needs to be evolved adaptively during the computation. Here some theoretical details of such a self-adaptive mesh refinement procedure are discussed Then, for the Dirichlet problem on an L-shaped domain as a model problem, some possible implementation techniques are presented, and various experimental results which indicate the effectiveness of the approach are given. (19 figures) (auth)

4424 (ORO—3817-4) **Investigation of a system for displaying computer outputs to the kinesthetic sense. Final technical report, June 1, 1968—June 30, 1973.** Brooks, F.P. Jr. (North Carolina Univ., Chapel Hill (USA). Dept. of Computer Science). 22 Apr 1975. Contract AT(40-1)-3817. 163p. Dep NTIS $11.25.

Research closely followed the plan originally proposed: the hardware development, programing development, and human-factors evaluation of two systems for display to the sense of feel. A pilot system, with two degrees of freedom, was to test basic feasibility, delineate pitfalls, and provide an evaluation methodology. Development of a full-scale system, using a remote manipulator with full seven degrees of freedom (3 position, 3 orientation, 1 grip, equivalently), was to be started but not completed under this contract, as extended. The two-degree system was built, programed, and thoroughly evaluated, and the results were published internationally. Human factors experiments showed that test groups of motivated users were able to understand and use computer outputs better when visual displays were supplemented with force displays than were control groups furnished identical visual displays alone. A 7-degree system was built and a pilot programing system was developed. Results showed grossly satisfactory functional operation but inability to operate in real time, by a factor of 50 to 100. This pilot experiment showed where the difficulties seemed to lie. Follow-on work done under NSF auspices is currently completing a much modified and improved full, real-time 7-degree system. (auth)

4425 (RL—75-116) **Intersection of two quadrilaterals in a plane.** Bryan, D.; Armstrong, A.G. (Science Research Council, Chilton (UK). Rutherford Lab.). Jul 1975. 10p. Dep. NTIS (US Sales Only) $4.00.

The intersection of two quadrilaterals lying in a plane uses the concept that any side of one quadrilateral cuts the plane into two halves, the open half plane and the closed half plane; then, by checking the nodes of the other quadrilateral and vice versa, the intersection can be determined. (2 figures) (auth)

4426 (RT/FI—(75)9) **Subroutine for plotting contour maps on plane networks with triangular meshes.** Cinti, P. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). May 1975. 31p. (In Italian). Dep. NTIS (US Sales Only) $4.50.

The subroutine TRAMP for plotting contour maps for a two-arguments function defined on nodal points or centers of gravity of triangular meshes and approximated by a polyhedron surface with triangular plane plates is described. The search of equal elevation points is done along the edges of the plates; techniques for smoothing the contours obtained are not used. Among the options provided are clockwise rotation by a right angle in order to avoid the limitation of drawing paper height and the printing of the elevation on the corresponding contours. Some examples are presented. (15 figures) (auth)

4427 (SAND—74-5281) **Systematized collection of codes for solving two-point boundary-value problems.** Scott, M.R.; Watts, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 41p. (CONF-750902—7). Dep. NTIS $5.25.

From 80. national meeting of the American Institute of Chemical Engineers; Boston, Massachusetts, USA (7 Sep 1975).

A collection of codes for the numerical solution of boundary-value problems is described; insofar as possible, the arguments of call lists are identical in name and usage. The codes are planned for routine solutions by such means as the finite difference method or the multiple shooting method with variable step integrator. The methods used by the presently available codes are discussed, and the performance of SUPORT, INVIMB, SUPORQ, and SHOOT1 are shown for several sample problems. Code listings are not provided. (13 tables) (RWR)

4428 (SAND—75-0038) **Structural mechanics computer plotting handbook.** Beisinger, Z.E.; Benzley, S.E. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 48p. Dep. NTIS $5.00.

Current capabilities for plotting data generated from structural analysis codes are summarized. Information concerning both the codes that generate plot commands and the machines that create the plots is presented. Instructions on obtaining both printed and plotted microfiche output are also provided. (8 figures, 8 tables) (auth)

4429 (SAND—75-0147) **CDC 6600 subroutines for Bessel functions and Airy functions.** Amos, D.E.; Daniel, S.L.; Weston, M.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 38p. Dep. NTIS $5.00.

Subroutine BESJ implements the power series, the asymptotic expansion for x yields infinity, and the uniform asymptotic expansion for ν yields infinity for J/sub ν/(x). In the region $x > \nu$ forward recursion is stable, and values from the asymptotic expansion for x yields infinity with small ν are used to start the recursion for $x > 20$. Except for $x < {}^1/_2$, where the series is used, the Miller backward recursive algorithm, normalized by the power series or the expansion of ν yields infinity, is utilized to compute sequences of Bessel functions and cover other parts of the (ν,x) plane where no normalization expression is available. The normalization is always computed first with the leading term tested for underflow before any extensive computation is done. Chebyshev expansions on appropriate intervals are used in functions AIRY and DAIRY for the Airy functions Ai(x) and Ai'(x), respectively. A scaling option to remove the exponential decay for $x > 0$ is also available. (12 figures) (auth)

4430 (SAND—75-0148) **CDC 6600 subroutines for Bessel functions.** Amos, D.E.; Daniel, S.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 7p. Dep. NTIS $4.00.

Rational approximations on suitable intervals are implemented to compute $J_0(x)$ or $J_1(x)$ in subroutine BESJ01. Similar approximations are implemented for $Y_0(x)$ or $Y_1(x)$ on $x > 0$ in subroutine BESY01. $J_0(x)$ and $J_1(x)$ for $x > 0$ are also computed and returned from BESY01. (auth)

4431 (SAND—75-0149) **CDC 6600 subroutines for Bessel functions.** Amos, D.E.; Daniel, S.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 9p. Dep. NTIS $4.00.

Chebyshev approximations on suitable intervals are implemented in subroutine BESI01 to compute $I_0(x)$ or $I_1(x)$. An option for scaling by exp(-absolute value of x) is also provided. Similar approximations with an option for exp(x) scaling are implemented in subroutine BESK01 for $K_0(x)$ and $K_1(x)$ on $x > 0$. (auth)

4432 (SAND—75-0151) **CDC 6600 subroutine for Bessel functions.** Amos, D.E.; Saniel, S.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. 8p. Dep. NTIS $4.00.

Subroutine BESKN implements the three-term recursion relation for K/sub ν/(x) in forward recursion starting with Bessel function values for two consecutive integers. If ν is less than 35, $K_0(x)$ and $K_1(x)$ are generated for the first members of the recursion relation. If ν is greater than or equal to 35, the uniform asymptotic expansion is used. The subroutine is also designed for scaled functions, exp(x)K/sub ν/(x), as well as sequences of scaled or unscaled functions. Except for small orders, the leading term of the asymptotic expansion can be used to determine whether K/sub ν/(x) is within the exponent range of the machine. If it is, then BESKN computes the proper value with relative errors on the order of 10^{-12}. (auth)

4433 (SAND—75-0152) **CDC 6600 subroutine for Bessel functions.** Amos, D.E.; Daniel, S.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 26p. Dep. NTIS $4.50.

Subroutine BESI implements the power series, the asymptotic expansion for x yields infinity, and the uniform asymptotic expansion for ν yields infinity for I/sub ν/(x). For pairs (ν,x) not covered by one of these formulas, ν is raised by an integer (never more than 36) so that the backward recursive Miller algorithm can be normalized by one of these formulas. The order is then reduced by backward recursion on the three-term recursion relation. Sequences are also handled in this fashion, except in the region covered by the asymptotic expansion for x yields infinity and the region $x < {}^1/_2$ covered by the series where two starting values are obtained from the appropriate expansion. The normalizing relation is always computed first with the leading term tested for under- or over-flow, where appropriate, before any extensive computation is done. Scaled values exp(-x)I/sub ν/(x) are also computed as an option. These features make the routine very robust, giving good results whenever the function value is within the exponent range of the machine. Large orders (in excess of 10,000) are possible with relative errors on the order of 10^{-12}. (2 figures) (auth)

4434 (SAND—75-0428) **Instruction manual for the minicomputer system of division 2151.** Machin, E.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 28p. Dep. NTIS $4.00.

This document provides basic step-by-step instructions for use of the HP 2114A minicomputer system in Division 2151. These instructions cover the range from loading magnetic tapes on the magnetic tape unit to putting the computer into a usable condition to control the peripheral equipment. Description and use of some of the available subroutines are provided, as well as the procedure for processing HP Fortran programs to obtain usable binary object tapes. Instructions to the HP 2114A computer through the computer switch register are always by the base-8 numerical number system. A brief description of the base-8 number system and the computer switch register is also included. Detailed and in-depth information on the minicomputer, peripherals, and subroutines are not available in this document. Its sole purpose is to permit one to utilize the minicomputer system after only a minimum of familiarization with the equipment. (1 figure, 2 tables) (auth)

4435 (SAND—75-0450) **Solving systems of nonlinear equations.** Shampine, L.F.; Gordon, M.K. (Sandia Labs., Albuquerque, N.Mex. (USA)). Aug 1975. Contract AT(29-1)-789. 25p. Dep. NTIS $4.00.

The reader is introduced to the problem of obtaining roots of systems of nonlinear equations. Some methods are discussed along with some of their more obvious difficulties and relative merits. The basic ideas of the code QN are exposed and the reader instructed in its use. Details of the implementation are included for reference. Some numerical experiments are described to place the performance of the code in perspective. (auth)

4436 (SAND—75-0539) **Systemized collection of codes for solving two-point boundary-value problems.** Scott, M.R.; Watts, H.A. (Sandia Labs., Albuquerque, N.Mex. (USA)). Nov 1975. Contract AT(29-1)-789. 37p. Dep. NTIS $5.00.

A systematized collection of codes for solving linear and nonlinear two-point boundary-value problems is presented. The techniques are based on initial-value methods and include an orthonormalization procedure, invariant imbedding, and shooting. The codes are portable and are designed with user convenience the primary objective. Examples are presented to illustrate the performance of the codes. (1 figure, 17 tables) (auth)

4437 (SAND—75-5218) **Estimating the relationship between two distribution functions.** Steck, G.P.; Hanson, D.L. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 3p. (CONF-750904—2). Dep. NTIS $4.00.

From 40. session of the international statistical institute; Warsaw, Portugal (1 Sep 1975).

Consider two continuous distribution functions related by $G(x) = h[F(x)]$. Previous work has developed a confidence region estimator for h and given a lower bound for its coverage probability. In this paper a formula is given for the asymptotic coverage probability of this confidence region from which it is concluded that the lower bound is approachable. (auth)

4438 (SAND—75-5973) **Lower bounds for the multivariate normal Mills' ratio.** Steck, G.P. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 9p. (CONF-751113—2). Dep. NTIS $4.50.

From 1. ERDA statistical symposium; Los Alamos, New Mexico, USA (3 Nov 1975).

Lower bounds are derived for the multivariate Mills' ratio by expressing it as an expectation of a convex function and using Jensen's inequality. (1 table) (auth)

4439 (SAND—75-6062) **Exact digital models of continuous linear systems.** Stearns, S.D. (Sandia Labs., Albuquerque, N.Mex. (USA)). 1975. 6p. (CONF-751109—5). Dep. NTIS $4.50.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

Methods are described for obtaining simulations of linear systems that are exact, i.e., free of error, for specific classes of inputs. Exact digital models of the simple geophone are used for examples. An error bound is derived for exact models used in inexact situations. (13 figures) (auth)

4440 (SAND—75-8043) **Application of the state machine to digital control and I/O interface design.** Macmillan, D.C. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 34p. Dep. NTIS $4.75.

Two applications of the state machine concept to digital control are discussed. Algorithms and hardware are described for an analog/digital converter/computer interface and for blackjack dealer system. While the state machine is easy to debug and convenient for organizing complex tasks, it is a good choice only when time will not permit the use of a microcomputer. (9 figures) (auth)

4441 (SAND—75-8281) **User's guide to the Sandia Mathematical Program Library at Livermore.** Huddleston, R.E.; Jefferson, T.H. (Sandia Labs., Livermore, Calif. (USA)). Sep 1975. Contract AT(29-1)-789. 88p. Dep. NTIS $7.50.

The Sandia mathematical program library is a collection of general-purpose routines which are primarily mathematical in nature. Routines exist for the following applications: data fitting, eigenvalues and eigenvectors of matrices, Fourier transforms, linear algebraic equations, linear programming and game theory, numerical quadrature, numerical sorting, ordinary differential equations, special functions, zeros of functions and optimization, zeros of polynomials, and library error check routine and user options. Routines are listed alphabetically, with abstract and a description of parameters. (RWR)

4442 (SGAE—2408) **IBM 360/30—PDP 11/20 computer coupling and simulation of the IBM 1130/1800 plotter subroutines using this coupling.** Jakubczyk, G.M.; Krotz, W. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf. Forschungszentrum). Jan 1975. 56p. (In German). Dep. NTIS (US Sales Only) $5.50.

In the SGAE Computer Center a PDP 11/20 is used as a front end processor for the IBM 360/30. According to a project which is going to be worked out the tasks of the front end processor are handling of a plotter and a display for the /360, processing of DECtapes for the /360, telecommunication with a commercial computer, and control of other telecommunication lines later on. Compared with this project, the plotting system described here is a simple preliminary version which enables users to keep their existing IBM 1130 plotting programs with slight changes and to go on programing in their familiar language, until the demanding new system is finished. (8 figures) (auth)

4443 (STAN-CS—75-496) **Iterative block Lanczos method for the solution of large sparse symmetric eigenproblems.** Underwood, R.R. (Stanford Univ., Calif. (USA). Dept. of Computer Science). May 1975. 138p. (SU—326P30-41). Dep. NTIS $10.00.

Thesis.

This dissertation discusses the development, implementation, and application of an algorithm to solve the following problem: Compute accurate approximations to the r least eigenvalues of a large, sparse symmetric matrix A, where r is much less than n, the order of A. Application of common algorithms for solving general symmetric eigenproblems would require excessive computer time. The method considered is organized about a block Lanczos algorithm, which is an extension and generalization of a method originally proposed by Lanczos. Numerical examples and a listing of the computer program are included. (8 tables) (RWR)

4444 (SU—326-P30-43) **Numerical analysis. Progress report, July 1, 1974—August 15, 1975.** Golub, G.H. (Stanford Univ., Calif. (USA)). 1975. 17p. Dep. NTIS $4.00.

The titles of work completed are listed. Work is in progress in the following areas: solution of Poisson's equation with the conjugate gradient method; computing a regularization parameter for least-squares problems; approximate methods for time-dependent partial differential equations; an adaptive finite difference solver for nonlinear two-point boundary problems; cross validation program; sparse eigenvalue problems; and the conjugate gradient method for nonlinear problems. (RWR)

4445 (TID—26885) **Programming language I for the Varian - PLCV.** Jacobs, J.J. (North Carolina Univ., Chapel Hill (USA). Dept. of Computer Science). 1971. 77p. Dep. NTIS $7.00.

Thesis.

Programing Language I for the Varian, PLCV, is a subset of PL/I. Its features include scaled fixed-point arithmetic, bit and character string processing, input/output facilities, and the capability to interface with Varian assembly-language programs. PLCV runs on the IBM System/360 and generates code in the form of relocatable binary object decks for Varian 620/i or 620/f computers. A linkage editor is also provided to relocate PLCV object decks and combine them with object decks which are output of GIF, a System/360 assembler for the Varian 620/i written by the Stanford Linear Accelerator Center. The powerful language capabilities of PLCV combined with the GIF assembler should provide the user with the ability to generate a wide range of Varian programs by using the IBM System/360 as the compiling medium. (auth)

4446 (UCCND-CSD—18) **Mathematics and Statistics Research Department progress report for period ending June 30, 1975.** Coveyou, R.R.; Gosslee, D.G.; Wilson, D.G. (comps.). (Oak Ridge National Lab., Tenn. (USA)). Oct 1975. Contract W-7405-eng-26. 73p. Dep. NTIS $5.45.

Brief reports on mathematical and statistical research and consulting and collaboration are given for the following areas: statistical estimation, statistical testing, experimental design, probability, energy systems modeling, continuum mechanics, matrices and other operators, numerical analysis, biomathematics and biostatistics, analytical chemistry, biology and medicine, health physics research, management, materials research, physics research, and programming. Information on seminars, publications, etc., is also included. (10 figures, 4 tables) (RWR)

4447 (UCCND-CSD—21) **Response surface designs for the detection of model inadequacy.** Jones, E.R.; Mitchell, T.J. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 235p. Dep. NTIS $7.60.

Thesis.

In many experiments, it is tentatively assumed that the experimental response is related to some independent variables, x, by $eta_1(x) = x'_1\beta_1$. However, there is frequently some doubt whether this model adequately approximates the true response function, so a lack of fit test is used as part of the analysis. It may be supposed that the true response function is $eta(x) = x'_1\beta_1 + x'_2\beta_2$. This investigation has concentrated on the development and evaluation of criteria for the selection of experimental designs that have good properties for the detection of model inadequacy. The inadequacy of the proposed model is measured by the positive definite quadratic form $tau = sigma^{-2}\beta'_2T\beta_2$, where T is specified by the experimenter according to his own interests. Two choices for tau are proposed: tau_1, tau, tau_2, one is independent of the design, whereas the other depends upon the experimental design. Several criteria examined are invariant under non-singular linear transformations of the independent variables provided that tau is invariant to such transformations. Optimal designs for all of these criteria are obtained and evaluated for a variety of cases. (78 figures, 19 tables) (auth)

4448 (UCCND-CSD—24) **Numerical computation of the matrix exponential with accuracy estimate.** Ward, R.C. (Oak Ridge National Lab., Tenn. (USA)). Nov 1975. Contract W-7405-eng-26. 27p. Dep. NTIS $4.00.

An algorithm for computing the exponential of an arbitrary n x n matrix is presented and analyzed. Diagonal Pade Table approximations are used in conjunction with several techniques for reducing the norm of the matrix. An important feature of the algorithm is that an estimate for the minimum number of digits accurate in the norm of the computed exponential matrix is returned to the user. In obtaining this estimate, several interesting results concerning rounding errors and Pade approximations are presented. (auth)

4449 (UCID—16899) **Matrix multiplication by diagonals on vector/parallel processors.** Karush, J.I.; Madsen, N.K.; Rodrigue, G.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Aug 1975. Contract W-7405-Eng-48. 19p. Dep. NTIS $4.00.

A new technique for performing matrix multiplication on vector/parallel processors is discussed. The new algorithm is most efficient when the matrices involved have narrow-banded structures, but is still competitive for full matrices. (2 figures) (auth)

4450 (UCID—16915) **PATTER: a polyalgorithm for the analysis of generalized data sets, principles and practice.** Cox, L.A. Jr.; Bender, C.F. (California Univ., Livermore (USA). Lawrence Livermore Lab.). Oct 1975. Contract W-7405-Eng-48. 88p. Dep. NTIS $5.45.

A revision of the RECOG code, PATTER is designed to be faster and easier to use in an interactive mode, especially where fast graphics devices are available. PATTER offers extensive facilities for modeling analytical processes and solving complex data analysis problems by using many of the techniques of statistics, spectral analysis, and, specifically, pattern recognition. It is written in FORTRAN IV, primarily for CDC 6000 and 7000 computers, but it is essentially compatible with other FORTRANs. (2 figures) (RWR)

4451 (UCID—16919) **Automated analysis of operating systems written in higher-level languages.** Wetherell, C.S. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 3 Oct 1975. Contract W-7405-Eng-48. 11p. Dep. NTIS $4.50.

Techniques are known for creating data bases for system analysis of assembly language programs. By using modern compiler techniques, it is possible to parse PL/I and other higher-level computer languages into retrieval data bases. The actual information extracted from the higher-level languages is primarily linguistic, reflecting the biases of the designer, but it is possible to extract almost any information necessary to the system analyst. (2 figures) (auth)

4452 (UCID—30098(Rev.1)) **BLIB76 subroutine library and macro file CF76 compatible with the BLIBSTAR subroutine library and macro file CFSTAR.** Long, G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Aug 1975. Contract W-7405-Eng-48. 82p. Dep. NTIS $5.45.

This document describes the BLIB76 subroutine library and macro file CF76 that perform ASCII I/O, binary I/O, file management, and message handling for the CDC 7600. The BLIBSTAR subroutine library and macro file CFSTAR perform the same functions for the CDC STAR-100. (2 tables) (auth)

4453 (UCID—30113(Pt.1)) **Finding LLL computer documentation. Part I. TRIX DOCUMENT: a quick way to get information on any computer document.** Dawson, K.A. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Sep 1975. Contract W-7405-Eng-48. 16p. Dep. NTIS $4.50.

TRIX DOCUMENT helps LLL computer users locate computer documentation. Users may interactively search a complete and up-to-date list of citations of computer-related documents from 13 series of published LLL reports. All or a subset of these report citations may be searched on line for the occurrence of an arbitrary pattern, which may be an author's name, a word from a report title, a report number, etc. The citations matched in such a search may be displayed to the user's teletypewriter or television monitor, or may be placed in a disk file for off-line printing. TRIX DOCUMENT is a dialect of the TRIX language, an interactive, interpretive string-manipulation language developed at LLL. The dialect is available in public files on CDC 7600 and CDC 6600 computers. (auth)

4454 (UCID—30113(Pt.2)) **Finding LLL computer documentation. Part 2. Citation searching with master control.** Elchesen, D.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 10 Sep 1975. Contract W-7405-Eng-48. 18p. Dep. NTIS $4.50.

Procedures are described for performing on-line and batch-mode searches of LLL computer documentation via the MASTER CONTROL (MCP) retrieval program. The data base contains full bibliographic citations to all (unclassified) documents in the TID Library collection relating to the central LLL computer facility. All pertinent data elements may be searched, including author's name, document title, subject headings, index terms, report number, and year of publication. Users may search for word roots, word stems, whole words, phrases, and synonymous terms. The scope of a search may be progressively refined. Retrieved citations may be printed on the teletypewriter or high-speed printer, and displayed on the television monitor (TMDS) in several output formats. Typical searches take an average of two to three seconds. The data base is available from tape or Photostore. MCP is a public file on the CDC 7600 and CDC 6600 computers. (1 figure) (auth)

4455 (UCID—30115) **User's guide to slope, a simulator of the scope operating system executable under the Livermore Time Sharing System on CDC 7600 computers at LLL.** Johnston, W.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 15 Aug 1975. Contract W-7405-Eng-48. 29p. Dep. NTIS $5.00.

SLOPE is Lawrence Livermore Laboratory's implementation of CDC's SCOPE/KRONOS operating system for the CDC 7600 computer. Available as an executable program on the Livermore timesharing system (LTSS), SLOPE enables users to run SCOPE jobs brought from outside and to set up SCOPE-like jobs that can be run under SCOPE elsewhere. This guide introduces users to the use of the SLOPE system and to the SLOPE reference manual, which is available on line on LTSS. Since the SLOPE user must make use of LTSS software in doing input and output, and LTSS is a different operating system from SLOPE, this report shows how to convert files and tapes from one system to the other. Listings of input and output files, and of teletypewriter interactions, are included. (2 figures, 3 tables) (auth)

4456 (UCID—30119) **GEARV: a vectorized ordinary differential equation solver.** Morris, D.B.; Hindmarsh, A.C. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 22 Oct 1975. Contract W-7405-Eng-48. 41p. Dep. NTIS $4.00.

GEARV is a package of subroutines for the numerical solution of systems of ordinary differential equations, given the initial values. It is a vectorized version of the GEAR package (UCID-30001, Rev. 3), and is good for both stiff and nonstiff systems. The package contains both the implicit Adams methods and the backward differentiation formulas, or the methods of C.W. Gear, as options. (auth)

4457 (UCID—30121) **VALID: a routine to validate input data.** Overman, W.T.; Ramus, J.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Oct 1975. Contract W-7405-Eng-48. 23p. Dep. NTIS $4.50.

The VALID computer program checks input data for conformance to user-defined specifications. A context-free grammer is used to specify the format character sequence, or numeric range for each category of input data. Data may be supplied as free-form text or in a fixed-field card image form. The program allows on-line correction or erroneous data if the user desires that option. (auth)

4458 (UCID—30122) **TOFENIX: an aid in converting programs from CHAT to FENIX.** Martin, J.T. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 12 Nov 1975. Contract W-7405-Eng-48. 5p. Dep. NTIS $4.00.

TOFENIX accepts CHAT source code and indicates how that source must be changed in order for it to be compiled correctly by FENIX (the STAR compiler). The CHAT source must first be submitted to the preprocessor PRECOMP, which handles macro expansions, DIF and PARAMETER statements. PRECOMP produces an expanded source which may then be submitted to TOFENIX. TOFENIX expects the source to be error-free. It does not pinpoint syntax errors (although they are indicated in a general way). TOFENIX was designed to be applied to running codes to help convert from CHAT compilation to FENIX compilation. It runs on the 7600 only. (auth)

4459 (UCRL—51694(Rev.2)) **Octal debugging program (ODT-80) for the MCS-80 computer.** Fisher, E.R. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 17 Oct 1975. Contract W-7405-Eng 48. 12p. Dep. NTIS $4.00.

ODT-80 is an octal debugging routine for use on the Intel 8080 microprocessor. This routine provides the capability to examine and modify all of the memory that is available to the microcomputer and transfer program control to the created program. ODT-80 makes use of simple keyboard commands from any terminal--such as a teletypewriter--that is attached to the system. (2 figures) (auth)

4460 (UCRL—51829) **Fault trees for decision making in systems analysis.** Lambert, H.E. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 9 Oct 1975. Contract W-7405-Eng-48. 351p. Dep. NTIS $10.60.

Thesis.

The application of fault tree analysis (FTA) to system safety and reliability is presented within the framework of system safety analysis. The concepts and techniques involved in manual and automated fault tree construction are described and their differences noted. The theory of mathematical reliability pertinent to FTA is presented with emphasis on engineering applications. An outline of the quantitative reliability techniques of the Reactor Safety Study is given. Concepts of probabilistic importance are presented within the fault tree framework and applied to the areas of system design, diagnosis and simulation. The computer code IMPORTANCE ranks basic events and cut sets according to a sensitivity analysis. A useful feature of the IMPORTANCE code is that it can accept relative failure data as input. The output of the IMPORTANCE code can assist an analyst in finding weaknesses in system design and operation, suggest the most optimal course of system upgrade, and determine the optimal location of sensors within a system. A general simulation model of system failure in terms of fault tree logic is described. The model is intended for efficient diagnosis of the causes of system failure in the event of a system breakdown. It can also be used to assist an operator in making decisions under a time constraint regarding the future course of operations. The model is well suited for computer implementation. New results incorporated in the simulation model include an algorithm to generate repair checklists on the basis of fault tree logic and a one-step-ahead optimization procedure that minimizes the expected time to diagnose system failure. (80 figures, 20 tables) (auth)

4461 (UCRL—51878) **Numerical inversion of the Fourier transform: a combination trapezoidal and Filon technique.** Dudley, D.G. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 Aug 1975. 17p. Dep. NTIS $4.00.

A method is presented for combining the features of trapezoidal integration with Filon's method in order to produce an efficient numerical inversion of the Fourier transform. A fully documented FORTRAN language subroutine is developed which allows transformation from either time to frequency or frequency to time. (1 figure) (auth)

4462 (UCRL—51940) **Floating-point package for Intel 8008 and 8080 microprocessors.** Maples, M.D. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 24 Oct 1975. Contract W-7405-Eng-48. 43p. Dep. NTIS $5.00.

The Lawrence Livermore Laboratory has used a scientific-notation mathematics package that performs floating-point arithmetic with Intel 8008 and 8080 microprocessors. The execution times for the mathematical operations - add, subtract, multiply, divide, and square root - range from 3 to 77 ms. Instructions for using the floating-point package and a source listing of it are included. (1 figure, 9 tables) (auth)

4463 (UCRL—76542(Rev.1)) **Two-dimensional spectral factorization with applications in recursive digital filtering.** Ekstrom, M.P.; Woods, J.W. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 20 Feb 1975. 52p. (CONF-750486—1). Dep. NTIS $5.50.

From IEEE international symposium on circuits and systems for 1976; Munich, F.R. Germany (27 Apr 1975).

The concept of spectral factorization is extended to two dimensions (2-D) in such a way as to preserve the analytic characteristics of the factors. The factorization makes use of a homomorphic transform procedure due to Wiener. The resulting factors are shown to be recursively computable and stable, in agreement with one-dimensional spectral factorization. The factors are not generally 2-D polynomials but can be approximated as such. These results are applied to 2-D recursive filtering, filter design, and a computationally attractive stability test for recursive filters. (11 figures) (auth)

4464 (UCRL—76835) **Look at mass storage.** Boer, G.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 5 May 1975. 14p. (CONF-750538—2). Dep. NTIS $4.00.

From Conference on energy related modeling and data base management; Upton, New York, USA (12 May 1975).

The LLL Octopus Network and its associated mass storage devices are described. The IBM Photostore is in use at present. Future devices also discussed are the CDC Mass Storage Facility (MSF), Precision Instruments (PI) System 190, and IBM 3850, among others. (4 figures) (RWR)

4465 (UCRL—77279) **Development of design automation codes using software engineering methods.** Smith, R.J. II.

(California Univ., Livermore (USA). Lawrence Livermore Lab.). 28 Aug 1975. 12p. (CONF-751109—1). Dep. NTIS $4.00.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

The Electrical Engineering Department of the Lawrence Livermore Laboratory (LLL) has recently formed a Design Automation (DA) Group responsible for development of new DA capabilities at the Laboratory. This paper briefly discusses the environment in which the software is being produced, and methodologies employed by the development team. The discussion of software engineering approaches should be of interest to small groups producing relatively large complex software systems. (3 figures) (auth)

4466 (UCRL—77285) **Approach to detecting synchronization errors in concurrently executable programs.** Yamamoto, R.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 14 Oct 1975. 7p. (CONF-751109—6). Dep. NTIS $4.50.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

An approach to detecting a class of asynchronous errors is presented. Flow graphs are constructed from assembly language source codes of program modules. Reductions are performed on flow graphs such that errors can be found without exhaustive examination of program texts. (4 figures) (auth)

4467 (UCRL—77414(Rev.1)) **Measurement and evaluation of the Livermore time-sharing system for the CDC 7600.** Owens, J.L. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 4 Nov 1975. Contract W-7405-Eng-48. 16p. (CONF-751011—5). Dep. NTIS $4.50.

From 13. AESOP meeting; Chicago, Illinois, USA (22 Oct 1975).

Lawrence Livermore Laboratory, because of its special needs in time-sharing, developed its own operating system for its CDC 7600 computers. Monitoring programs to measure the performance of this operating system were developed, and the results were evaluated to identify and correct bugs in the system. Backlogs that had been attributed intuitively to heavy loads on the system were shown actually to be due to system bugs. This report describes the monitoring programs and gives a sample of their output. (auth)

4468 (UCRL—77447) **Kalman strip filter: two-dimensional recursive vector processor.** Woods, J.W.; Radewan, C.H. (California Univ., Livermore (USA). Lawrence Livermore Lab.). 31 Oct 1975. 8p. (CONF-751109—8). Dep. NTIS $4.50.

From 9. annual asilomar conference on circuits, systems and computers; Pacific Grove, California, USA (3 Nov 1975).

The Kalman Strip Filter is introduced as a new approximation to the Kalman Vector Filter, which processes a line at a time. The Kalman Strip Filter processes overlapping strips and is not limited to separable or exponential covariance functions as in previous two-dimensional Kalman vector filters. An optimum strip width is determined that minimizes computation. Finally, an example of the Filters performance is presented and discussed. (3 figures) (auth)

4469 (USC—133P19-92) **Mathematics in science, engineering, and energy processes. Progress report, June 1, 1974—May 31, 1975.** Bellman, R. (University of Southern California, Los Angeles (USA). Dept. of Electrical Engineering). 1975. Contract AT(04-3)-113. 26p. Dep. NTIS $5.00.

The activities of the members of the Electronic Sciences Laboratory at the University of Southern California in the area of mathematics as applied to science, engineering, and energy processes are briefly reviewed. (RWR)

4470 **Dominance of nth order linear equations.** Dolan, J.M.; Klaasen, G.A. (Oak Ridge National Lab., TN). *Rocky Mt. J. Math.*; **5**: No. 2, 263-270(Spr 1975).

Consider the nth-order linear equation y/sup (n)/ + Σ k = 1 to n pk/sup (x)/y/sup(n-k)/ = 0, where p/sub k/(x) belongs to c(a,infinity) for 1 is less than or equal to k is less than or equal to n. Introducing a new concept called dominance, the authors compare the asymptotic properties of the set of oscillatory solutions with the set or nonoscillatory solutions for the equation when dominance occurs. These results also give information about the number of linearly independent oscillatory or nonoscillatory solutions. The third-order equation is given concentrated attention. (auth)

4471 **Quadratic interpolatory splines.** Kammerer, W.J. (Georgia Inst. of Tech., Atlanta); Reddien, G.W.; Varga, R.S. *Numer. Math.*; **22**: 241-259(1974).

The projectional properties and associated global and local error bounds for quadratic interpolatory splines are studied, along with applications to the numerical solution of two-point boundary value problems via collocation. (3 tables) (auth)

4472 **Effect of variable mesh size on the stability of multistep methods.** Gear, C.W. (Univ. of Illinois, Urbana); Tu, K.W. *SIAM J. Math. Anal.*; **11**: No. 5, 1025-1043(Oct 1974).

The effects of two different techniques for implementing variable mesh sizes in multistep formulas are investigated. It is proved that one is stable for a greater variation in step sizes than the other with Adams formulas, but that both are stable when the rate of step changing is small with any multistep formula. The practical implications of these results are discussed. (auth)

4473 **Some computations of expected number of real zeros of random polynomials.** Kahaner, D.K. (Los Alamos Scientific Lab., NM). Contract W-7405-Eng-36. *J. Math. Anal. Appl.*; **48**: No. 3, 780-784(Dec 1974).

If P/sub n/(z) is a polynomial of degree n whose coefficients are each drawn from a normal population with mean 0 and variance 1, the number of real zeros of P/sub n/ an expectation denoted by ν/sub n/. In this note ν/sub n/ is computed for n < 101. Results accurate to seven decimal figures are obtained. (1 figure, 1 table) (RWR)

4474 **Cheap control of the time-invariant regulator.** Jameson, A. (New York Univ., NY); O'Malley, R.E. Jr. Contract AT(11-1)-3077. *Appl. Math. Optim.*; **1**: No. 4, 337-354(1975).

The asymptotic solution of the linear quadratic state regulator problem is obtained as the cost of the control tends to zero. Matrix Riccati gains are obtained via singular perturbations theory, and are used to calculate sasymptotically the optimal control and the corresponding trajectories. Several cases are distinguished and applications are discussed. (auth)

4475 **Periodic solutions of the KdV equation.** Lax, P.D. (New York Univ., NY). *Commun. Pure Appl. Math.*; **28**: 141-188(1975).

A large family of special solutions of the Korteweg-de Vries (KdV) equation which are periodic in x and almost periodic in t are constructed. These solutions lie on N-dimensional tori; very likely they are dense among all solutions. The special solutions are characterized variationally; they minimize F/sub N/(u), subject to the constraints F/sub j/(u) = A/sub j/, j = -1,..., N-1; here F/sub j/ denote the remarkable sequence of conserved functionals discovered by Kruskal and Zabusky. The above minimum problem was originally suggested by them. In exploring the manifold of solutions of this minimum problem essential use is made of Gardner's discovery that these functionals are in involution with respect to a suitable Poisson bracket. Gardner, Greene, Kruskal, and Miura have shown that the eigenvalues of the Schroedinger operator are conserved functionals if the potential is a function of t and satisfies the KdV equation. A new set of conserved quantities is constructed which serve as a link between the eigenvalues of the Schroedinger operator and the F/sub j/. Another result is a slight sharpening of an earlier result: for the special solutions constructed above all but 2N + 1 eigenvalues of the Schroedinger operator are double. The simplest class of special solutions, N = 1, are cnoidal waves. In an appendix, M. Hyman describes the results of computing numerically the next simplest case, N = 2. These calculations show that the shape of these solutions recurs exactly after a finite time, in a shifted position. The theory verifies this fact. (2 figures) (auth)

4476 **Mean, mean-square, and most-probable momentum for a relativistic maxwellian ensemble.** Wienke, B.R. (Los Alamos Scientific Lab., NM). *Am. J. Phys.*; **43**: No. 1, 317-318(Jan 1975).

Statistical moments of the relativistic Maxwell--Boltzmann momentum distribution are obtained from integral representations of modified Bessel functions. Approximate low-temperature (m/kT>> 1) behaviors for the mean and mean-square momenta are indicated via asymptotic expansions of corresponding Bessel functions, and the results are briefly contrasted with the usual classical predictions. The most probable momentum is also discussed. (auth)

4477 **Computer storage structure and utilization at a large scientific laboratory.** Fletcher, J.G.; Fernbach, S.; Dubois, P.J.; Boer, G.L. (Univ. of California, Livermore). *Proc. IEEE (Inst. Electr. Electron. Eng.)*; **63**: No. 8, 1104-1113(Aug 1975).

The Octopus computer network at the Lawrence Livermore Laboratory, University of California, Livermore, ties together one of the largest concentrations of computing capability in the world, serving about 1500 users. The network's information storage capacity is large in every range of access speed. There are computers with main memories of 30 Mbits and secondary storage of 10 Gbits, a shared tertiary store of 1 Tbit, and 30 to 40 thousand reels of magnetic tape. This storage supports correspondingly large numerical simulations and other application programs that require the continuous operation of four major computers. Efficient storage use necessitates proper design of algorithms and buffer structures on the part of both the users and the system implemen-

tors. The main problems that arise include maintenance of high data transfer rates, reliability in the presence of intermittent hardware failure, achieving balance between media with differing access speeds, flexibility of the indexing structure, and equitable allocation among users. The discussion covers these issues in some detail, and includes an historical perspective and estimates of future trends. (5 figures, 1 table) (auth)

4478 (SAND—75-0150) **CDC 6600 subroutines for Bessel functions and Airy functions.** Amos, D.E.; Daniel, S. (Sandia Labs., Albuquerque, N.Mex. (USA)). Sep 1975. Contract AT(29-1)-789. 11p. Dep. NTIS $4.00.

Subroutine BESYN implements the three-term recursion relation for Y/sub ν/(x) in forward recursion starting with Bessel function values for two consecutive integers. If ν is less than 100, $Y_0(x)$ and $Y_1(x)$ are generated for the first members of the recursion relation. If ν is greater than or equal to 100, the uniform asymptotic expansion is used. The subroutine is also designed for sequences of integer-order functions. Except for small orders, the leading term of the asymptotic expansion can be used to determine whether Y/sub ν/(x) is within the exponent range of the machine. If it is, then BESYN computes the proper value with errors on the order of 10^{-12}, the scale being absolute in the oscillation region and relative in the growth region near the origin. Chebyshev expansions on appropriate intervals are used in functions BAIRY and DBAIRY for the Airy functions Bi(x) and Bi'(x), respectively. A scaling option to remove the exponential growth for $x > 0$ is also available. (auth)

4479 **Semisimple graded Lie algebras.** Pais, A.; Rittenberg, V. (Rockefeller Univ., New York). *J. Math. Phys. (N.Y.)*; **16**: No. 10, 2062-2073(Oct 1975).

The concept of metric is introduced for graded Lie algebras. Semisimple graded Lie algebras are defined in terms of metric conditions of nonsingularity. It is shown that for this class of algebras the metric tensor generates a quadratic Casimir operator. Also for this class, the grading representation is irreducible, and its weights are related to the roots of the Lie algebra (''root-weight theorem''). The problem is solved to find all semisimple graded Lie algebras. For SU(N), $N > 2$, for O(N), $N > 5$, and for all exceptional groups there are none. For all other semisimple Lie algebras there is one and only one. These are explicitly constructed in terms of a convenient realization of Sp(2,N) matrices. SU(2) is discussed in some detail, and a new group [GSU(2)] is found which leaves a mixed c-number/q-number quadratic form invariant. Irreducible tensor operators for this group are also defined. SU(N), $N > 2$, provides examples of nonsemisimple gradings. (auth)

4480 **Time response and band width in laboratory automation.** Frazer, J.W.; Brubaker, T.A.; Van Drie, J.H. (Lawrence Livermore Lab., CA). *Proc. IEEE (Inst. Electr. Electron. Eng.)*; **63**: No. 10, 1503-1508(Oct 1975).

In laboratory automation, the computer is used for a variety of tasks including data acquisition, data analysis, control, and report and graph generation. For automation to be successful, it is necessary to generate system specifications carefully and to proceed to an implementation design before becoming concerned about the actual computer. This forces the design team to consider the requirements to handle and process data without the constraints of a specific computer. For real-time applications, two key specifications are time response and bandwidth. These quantities are defined and their effect on the operation of a computer system is discussed. A detailed example of an actual system is then presented to illustrate how time response and bandwidth are handled. (4 figures, 1 table) (auth)

4481 **Appell's function F_4 as a double average.** Carlson, B.C. (Ames Lab., IA). *SIAM J. Math. Anal.*; **6**: No. 6, 960-965(Nov 1975).

A quadratic transformation of a double hypergeometric series of order two (Appell's F_4 with equal denominator parameters) into a series of order three revives longstanding doubts about the accepted classification by order. Both series can be represented as double Dirichlet averages of x/sup t/. Appell's F_4 with unrestricted parameters can be represented as such an average with two rows and three columns. There are six cases in which a restriction on the parameters reduces the number of columns to two. (auth)

INFORMATION HANDLING

4482 (DP—1372) **Revised computer programs for ordering, listing, and circulating library books.** Feldman, M.S.; Wren, H.F.; Buhl, N.A. (Du Pont de Nemours (E.I.) and Co., Aiken, S.C. (USA). Savannah River Lab.). Aug 1975. Contract AT(07-2)-1. 55p. Dep. NTIS $5.45.

The Technical Library of the Savannah River Laboratory uses COBOL programs to assist in purchasing and circulating books and to provide book lists and printed catalogs. The programs are written for the IBM System/360-195 with 2kk byte storage capacity and may be used by a library of any size. Bibliographic and cataloging data for the library holdings are stored on magnetic tape from which data can be recalled in twenty-nine printout options to retrieve information concerning borrowers, authors, subject matter, inventory, etc. Book ordering is simplified, requiring only key-punched data cards as input and obtaining multiple purchase order forms as printout. The programs are improved over those reported earlier as follows: The data are more compact. Subject, series, and cross-reference files are maintained in the computer memory bank. Manual handling and sorting operations are eliminated; thus, key-punching of data input cards is the only manual operation remaining. (49 figures, 1 table) (auth)

4483 (EDFB-IBP—75-12) **NUTIS: numerical and textual information system. Version 1.1. A system's manual.** Taylor, D.G.; Strand, R.H. (Oak Ridge National Lab., Tenn. (USA)). Sep 1975. Contract W-7405-eng-26. 143p. Dep. NTIS $7.60.

In the development of a scientific information system, four distinct areas, data banking, subsetting-combining, statistical analysis, and simulation, are enhanced by the application of computer software. A detailed list of capabilities in each of the four areas was developed; through a thorough search, a number of computer software packages were identified that possessed the required capabilities in all of the areas except data banking. The absence of a good data banking software package led to the development and implemention of the Numerical and Textual Information System (NUTIS), an easy-to-use system which provides computerized storage and retrieval of textual and numeric information. (auth)

4484 (JINR—E10-8855) **Information retrieval system of JINR.** Arnaudov, D.D.; Govorun, N.N. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1975. 16p. Dep. NTIS (US Sales Only) $4.00.

The main principles and the structure of the basic files of the system are discussed. The information retrieval system is realized on the algorithmic language COBOL. (4 figures, 3 tables) (auth)

4485 (JINR—P11-9103) **Some combinatorial properties of a class of associative characteristic structures.** Sumarokov, V.M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Computing Techniques and Automation). 1975. 18p. (In Russian). Dep. NTIS (US Sales Only) $4.00.

The structure of the Landauer growing balanced tree of characteristics was changed in order to increase the speed of operation of the information retrieval algorithm. A combinatorial analysis of metrical properties of a modified structure was carried out, and the conditions of its optimum synthesis were obtained. The composition formalism was suggested to illustrate the pithy aspects of optimum realizations of the position and growing trees of characteristics. (auth)

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The descriptors selected for use as subject terms are generally the names of specific materials, things, or processes. To the extent possible, a qualifier is selected to describe the properties of, or processses applied to, the subject term.

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1233	1:3268	Dep. NTIS, $5.45
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1256	1:3171	Dep. NTIS, $5.45
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2	1:3707	See SAND-75-5425
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1	1:3292	See SAND-75-5987
2	1:4438	See SAND-75-5973
3	1:4403	Dep. NTIS, $4.50
7	1:3244	Dep. NTIS, $4.50
8	1:3877	See BNWL-SA-5571
CONF-751114-		
1	1:3091	See DP-MS-75-80
CONF-751115-		
2	1:3774	Dep. NTIS, $4.50
3	1:3060	Dep. NTIS, $4.50
4	1:3775	Dep. NTIS, $5.00
CONF-751116-		
3	1:3348	See UCRL-76912
CONF-751118-		
1	1:3039	See UCRL-77303
CONF-751120-		
1	1:3350	Dep. NTIS, $4.50
CONF-751122-		
1	1:3885	Dep. NTIS, $4.50
CONF-751125-		
13	1:4323	See ANL/HEP-CP-66
27	1:4315	See UCRL-77245
30	1:4386	See UCRL-77263
31	1:4331	See UCRL-77229
32	1:4347	See UCRL-77237
33	1:4385	See UCRL-77240
35	1:4307	Dep. NTIS, $4.50
44	1:4324	Dep. NTIS, $4.50
56	1:4334	See LA-UR-75-2127
57	1:4333	See LA-UR-75-2115
59	1:4244	See LA-UR-75-2077
CONF-751127-		
1	1:3639	See SAND-75-5502
CONF-751128-		
1	1:3817	See UCRL-77446
CONF-751129-		
1	1:3952	See LA-UR-75-2056
CONF-751204-		
1	1:3247	See UCRL-77371
CONF-751206-		
1	1:3802	See SAND-75-5731
CONF-751207-		
1	1:3835	See UCRL-77429
CONF-751209-		
2	1:3709	See SAND-75-6092
5	1:3422	Dep. NTIS, $4.50
8	1:3423	Dep. NTIS, $4.50
9	1:3427	See SAND-75-5807
COO-		
623-202	1:4176	Dep. NTIS, $7.50
958-52	1:3604	Dep. NTIS, $4.25
1428-425	1:4144	Dep. NTIS, $4.50
1428-428	1:4139	Dep. NTIS, $5.00
1545-170	1:4145	Dep. NTIS, $7.75
1569-124	1:3424	Dep. NTIS, $5.50
1599-95	1:3911	Dep. NTIS, $7.00
1763-48	1:3605	Dep. NTIS, $4.50
1794-25	1:3499	Dep. NTIS, $5.00
2013-23	1:3963	Dep. NTIS, $5.50
2164-13	1:3891	Dep. NTIS, $4.50
2184-7	1:4114	Dep. NTIS, $5.00
2218-38	1:4208	Dep. NTIS, $5.00
2218-40	1:4250	Dep. NTIS, $4.50
2232A-26	1:4136	Dep. NTIS, $4.50
2232A-27	1:4141	Dep. NTIS, $5.00
2232A-28	1:4137	Dep. NTIS, $4.50
2383-0025	1:4404	Dep. NTIS, $5.00
2408-2	1:3463	Dep. NTIS, $4.50
2521-1	1:3661	Dep. NTIS, $4.00
2529-1	1:3902	Dep. NTIS, $5.00
2571-2	1:3280	Dep. NTIS, $4.50
2620-1	1:3331	TIC
2702-1	1:3138	Dep. NTIS, $4.50

Report No.	Abstract No.	Availibility
2753-11	1:4105	Dep. NTIS, $4.00
3004-11	1:4299	Dep. NTIS, $4.50
3017-24	1:4059	Dep. NTIS, $4.50
3070-129	1:4300	Dep. NTIS, $4.50
3238-534	1:3606	Dep. NTIS, $4.50
3426-13	1:3871	Dep. NTIS, $5.00
3497-13	1:4269	Dep. NTIS, $4.50
CRN-CNPA-		
75-11	1:3806	Dep. NTIS (US Sales Only), $4.50
DEMO-		
75/5	1:4405	Dep. NTIS (US Sales Only), $5.00
75/9	1:4406	Dep. NTIS (US Sales Only), $4.00
DESY-		
75/24	1:4158	Dep. NTIS (US Sales Only), $4.75
DP-		
1372	1:4482	Dep. NTIS, $5.45
1391	1:3557	Dep. NTIS, $4.00
DP-MS-		
75-15	1:3673	Dep. NTIS, $4.25
75-43	1:4371	Dep. NTIS, $4.50
75-63	1:3097	Dep. NTIS, $5.00
75-73	1:3903	Dep. NTIS, $4.50
75-80	1:3091	Dep. NTIS, $4.00
75-87	1:4173	Dep. NTIS, $7.75
75-89	1:3659	Dep. NTIS, $4.00
DPST-		
75-128-8	1:3098	Dep. NTIS, $5.00
75-128-9	1:3099	Dep. NTIS, $5.00
E-		
8256	1:3116	*See* N-75-17406
EDFB-IBP-		
75-12	1:4483	Dep. NTIS, $7.60
EGG-		
1183-5051	1:3799	Dep. NTIS, $5.45
EIR-		
288	1:3104	Dep. NTIS (US Sales Only), $4.75
EPA-		
460/3-74-012a	1:3366	Dep. NTIS, $4.75
460/3-74-012b	1:3367	Dep. NTIS, $15.00
460/3-74-012c	1:3368	Dep. NTIS, $8.75
EPRI-TD-		
3	1:3181	NTIS, $5.00
ERDA-		
45(75/4)	1:3324	Dep. NTIS, $8.25
65	1:3353	Dep. NTIS, $4.00
66	1:3355	Dep. NTIS, $4.00
79	1:3298	Dep. NTIS, $7.60
86	1:3159	Dep. NTIS, $5.45
1217-75	1:3851	Dep. NTIS, $6.50
ERDA-tr-		
51	1:4060	Dep. NTIS, $7.60
52	1:3242	Dep. NTIS, $7.60
65	1:3869	Dep. NTIS, $7.60
69	1:4219	Dep. NTIS, $4.00
78	1:3187	Dep. NTIS, $12.75
EUR-		
5135d	1:3856	Dep. NTIS (US Sales Only), $8.50. EUR BF 125.-
5358e	1:3797	Dep. NTIS (US Sales Only), $5.75
5378e	1:3807	Dep. NTIS (US Sales Only), $5.00
FE-		
415-T2	1:3007	Dep. NTIS, $7.50
415-T3	1:3008	Dep. NTIS, $9.75
496-T4	1:3029	Dep. NTIS, $7.60
0497-2	1:3024	Dep. NTIS, $7.60
1207-1	1:3009	Dep. NTIS, $7.60
1527-1	1:3010	Dep. NTIS, $5.45
1533-T-2	1:3632	Dep. NTIS, $5.00
1733-T-1	1:3356	Dep. NTIS, $7.60
1767-T1	1:3011	Dep. NTIS, $5.45
1787-1	1:3043	Dep. NTIS, $4.50
1808-1	1:3330	Dep. NTIS, $7.75
2033-5	1:3005	Dep. NTIS, $4.50
FERMILAB-		
75/70-THY	1:4146	Dep. NTIS, $4.50
GA-A-		
13487	1:3194	Dep. NTIS, $4.50
13510	1:3061	Dep. NTIS, $7.60
13524	1:3195	Dep. NTIS, $5.45
13592	1:3196	Dep. NTIS, $7.60
GAT-T-		
2374	1:3089	Dep. NTIS, $4.00
GEAP-		
13317-10	1:3281	Dep. NTIS, $5.50
13825-13	1:3206	AT
13993(Rev.1)	1:3207	AT
14031-3	1:3208	AT
14045-2	1:3209	AT
14050	1:3406	AT
14051	1:3210	AT
14052	1:3881	AT
20950	1:3191	Dep. NTIS, $7.60
HAN-		
64841	1:3446	Dep. NTIS, $4.50
HEDL-SA-		
947	1:4372	Dep. NTIS, $5.25
948	1:4373	Dep. NTIS, $4.25
950	1:3090	Dep. NTIS, $4.00
951	1:4374	Dep. NTIS, $4.00
979	1:3257	Dep. NTIS, $5.00
985	1:3211	Dep. NTIS, $4.50
1012	1:3458	Dep. NTIS, $5.00
HEDL-TC-		
274(DR)	1:3282	Dep. NTIS, $7.00
HEDL-TME-		
75-3	1:3212	AT
75-41	1:3077	Dep. NTIS, $4.00
75-60	1:3283	AT
75-90	1:4375	Dep. NTIS, $5.45
75-97	1:3258	AT
HMI-B-		
161	1:4407	INIS
176	1:3808	Dep. NTIS (US Sales Only), $5.00
HW-		
44341	1:4087	Dep. NTIS, $4.50
64375	1:3088	Dep. NTIS, $5.00
IAEA-CN-		
33/A3-2	1:4213	*See* MATT-1094
33/A4-2	1:4212	*See* MATT-1092
33/A12-4	1:4275	*See* MATT-1095
33/A15-4	1:4326	*See* MATT-1079
33/G1-4	1:4310	*See* MATT-1082
ICP-		
1080	1:3078	Dep. NTIS, $5.45
IDO-		
10062	1:3165	Dep. NTIS, $4.00
IEA-		
38	1:4178	Dep. NTIS (US Sales Only), $9.00
INIS-mf-		
1720	1:3809	Dep. NTIS (US Sales Only), $4.50
IS-ICP-		
2	1:3000	Dep. NTIS, $5.25
IS-M-		
45	1:3407	Dep. NTIS, $5.00
IS-Trans-		
93	1:3561	Dep. NTIS, $4.50
ITP-		
74-170R	1:4184	Dep. NTIS (US Sales Only), $4.00
75-8P	1:4185	Dep. NTIS (US Sales Only), $4.00
75-35R	1:3513	Dep. NTIS (US Sales Only), $4.25
JINR-		
E2-8995	1:4204	Dep. NTIS (US Sales Only), $4.00
E10-8855	1:4484	Dep. NTIS (US Sales Only), $4.00
P4-8923	1:4186	Dep. NTIS (US Sales Only), $4.00
P4-8953	1:4187	Dep. NTIS (US Sales Only), $4.00
P4-9087	1:4196	Dep. NTIS (US Sales Only), $4.00
P9-9143	1:3810	Dep. NTIS (US Sales Only), $4.50
P10-9056	1:3811	Dep. NTIS (US Sales Only), $4.00
P11-8980	1:4408	Dep. NTIS (US Sales Only), $4.00

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P11-8982	1:3728	Dep. NTIS (US Sales Only), $4.00
P11-9103	1:4485	Dep. NTIS (US Sales Only), $4.00
P13-8890	1:3812	Dep. NTIS (US Sales Only), $4.00
P13-9132	1:4251	Dep. NTIS (US Sales Only), $4.50
R-4-8032	1:4188	INIS
JPRS-		
65836	1:3859	Dep. NTIS (US Sales Only), $4.50
JUL-		
1188	1:3108	Dep. NTIS (US Sales Only), $5.50
1195	1:3371	Dep. NTIS (US Sales Only), $7.00
1210	1:3552	Dep. NTIS (US Sales Only), $6.50
K-Trans-		
77	1:3647	Dep. NTIS, $4.50
KAPL-M-		
7399	1:3674	Dep. NTIS, $4.50
KFK-		
2178	1:4409	Dep. NTIS (US Sales Only), $5.00
KFK-EXT-		
8/75-2	1:3186	Dep. NTIS (US Sales Only), $5.00
KFK-PDV-		
37	1:4410	Dep. NTIS (US Sales Only), $7.50
38	1:3633	Dep. NTIS (US Sales Only), $4.75
39	1:4411	Dep. NTIS (US Sales Only), $7.75
40	1:4412	Dep. NTIS (US Sales Only), $8.00
44	1:4413	Dep. NTIS (US Sales Only), $13.75
45	1:3634	Dep. NTIS (US Sales Only), $5.75
46	1:3813	Dep. NTIS (US Sales Only), $5.00
49	1:4414	Dep. NTIS (US Sales Only), $8.25
51	1:4415	Dep. NTIS (US Sales Only), $5.00
52	1:4416	Dep. NTIS (US Sales Only), $5.50
KFKI-		
75-33	1:4189	Dep. NTIS (US Sales Only), $4.00
LA-		
4005	1:3462	Dep. NTIS, $4.50
5838	1:3635	Dep. NTIS, $5.45
5956-PR	1:3173	Dep. NTIS, $5.45
6003	1:4417	Dep. NTIS, $4.00
6005-MS	1:3284	Dep. NTIS, $4.00
6039	1:3538	Dep. NTIS, $4.00
6042-PR	1:3553	Dep. NTIS, $4.00
6053-PR	1:3184	Dep. NTIS, $4.00
6055-MS	1:3600	Dep. NTIS, $5.45
6076-MS	1:3841	Dep. NTIS, $4.00
6086—MS	1:3908	Dep. NTIS, $4.00
6090-MS	1:3839	Dep. NTIS, $4.00
6092-MS	1:3425	Dep. NTIS, $4.00
6100-PR	1:3079	Dep. NTIS, $5.45
6111-MS	1:3842	Dep. NTIS, $4.00
6122-MS	1:3314	Dep. NTIS, $4.00
LA-tr-		
75-30	1:3577	Dep. NTIS, $4.50
LA-UR-		
75-351	1:4322	Dep. NTIS, $4.50
75-877	1:3636	Dep. NTIS, $4.50
75-1422	1:3662	Dep. NTIS, $4.00
75-1463	1:3167	Dep. NTIS, $4.00
75-1490	1:4182	Dep. NTIS, $4.00
75-1502	1:4308	Dep. NTIS, $4.00
75-1506	1:4270	Dep. NTIS, $4.00
75-1513	1:4253	Dep. NTIS, $4.00
75-1541	1:4271	Dep. NTIS, $4.00
75-1542	1:4243	Dep. NTIS, $4.00
75-1558	1:4272	Dep. NTIS, $4.00
75-1565	1:4309	Dep. NTIS, $4.00
75-1566	1:4376	Dep. NTIS, $4.00
75-1567	1:4325	Dep. NTIS, $4.00
75-1568	1:4273	Dep. NTIS, $4.00
75-1577	1:4274	Dep. NTIS, $4.00
75-1590	1:3344	Dep. NTIS, $4.00
75-1628	1:3447	Dep. NTIS, $4.00
75-1722	1:3949	Dep. NTIS, $4.25
75-1727	1:3950	Dep. NTIS, $4.50
75-1741	1:3951	Dep. NTIS, $4.75
75-1846	1:4377	Dep. NTIS, $4.50
75-1872	1:4054	Dep. NTIS, $5.50
75-1873	1:4055	Dep. NTIS, $4.50
75-1915	1:3863	Dep. NTIS, $4.50
75-1939	1:4129	Dep. NTIS, $4.50
75-1983	1:3961	Dep. NTIS, $4.75
75-1985	1:3947	Dep. NTIS, $5.00
75-1988	1:3843	Dep. NTIS, $4.50
75-2030	1:4209	Dep. NTIS, $4.50
75-2056	1:3952	Dep. NTIS, $5.00
75-2061	1:3882	Dep. NTIS, $5.00
75-2077	1:4244	Dep. NTIS, $4.50
75-2115	1:4333	Dep. NTIS, $4.50
75-2127	1:4334	Dep. NTIS, $4.50
75-2155	1:3663	Dep. NTIS, $4.50
LAMS-		
2648	1:3266	Dep. NTIS, $5.50
LBL-		
3232	1:3164	Dep. NTIS, $4.50
3262	1:4210	Dep. NTIS, $4.00
3278	1:3109	Dep. NTIS, $11.00
3563	1:3372	Dep. NTIS, $4.50
3586	1:3391	Dep. NTIS, $8.50
3592	1:3701	Dep. NTIS, $4.00
3818	1:3857	Dep. NTIS, $4.00
3916	1:3664	Dep. NTIS, $4.00
3917	1:4121	Dep. NTIS, $7.75
3957	1:3464	Dep. NTIS, $7.75
3962	1:3392	Dep. NTIS, $10.75
4081	1:4168	Dep. NTIS, $5.50
4123	1:3426	Dep. NTIS, $5.50
4152	1:3408	Dep. NTIS, $5.50
4185	1:3559	Dep. NTIS, $7.75
4222	1:4155	Dep. NTIS, $4.00
4256	1:4418	Dep. NTIS, $4.00
4260	1:4149	Dep. NTIS, $4.50
4264	1:3973	Dep. NTIS, $10.00
4275	1:4153	Dep. NTIS, $6.50
4281	1:4138	Dep. NTIS, $7.75
4607	1:4419	Dep. NTIS, $4.00
LERC/RI-		
75/6	1:3057	Dep. NTIS, $4.00
LMEC-		
75-11	1:3259	AT
LMSC-D-		
056566(Vol.1)	1:3132	*See* NSF/RANN/SE/GI-C-937/FR/75/1(Vol.1)
056566(Vol.2)	1:3131	*See* NSF/RANN/SE/GI-C-937/FR/75/1(Vol.2)
384268	1:3115	*See* N-75-16085
LMSC-HREC-TR-D-		
390666	1:3152	*See* N-75-18719
MATT-		
1079	1:4326	Dep. NTIS, $4.00
1082	1:4310	Dep. NTIS, $4.00
1083	1:4327	Dep. NTIS, $4.00
1084	1:4301	Dep. NTIS, $5.50
1085	1:4245	Dep. NTIS, $4.50
1088	1:4211	Dep. NTIS, $4.00
1090	1:4302	Dep. NTIS, $4.00
1092	1:4212	Dep. NTIS, $4.00
1093	1:4255	Dep. NTIS, $4.50
1094	1:4213	Dep. NTIS, $4.00
1095	1:4275	Dep. NTIS, $4.00
1096	1:4276	Dep. NTIS, $4.00
1097	1:4277	Dep. NTIS, $4.00
1113	1:4214	Dep. NTIS, $6.00
1134	1:4328	Dep. NTIS, $4.25
1143	1:4256	Dep. NTIS, $4.00
1155	1:4311	Dep. NTIS, $5.00
1158	1:4312	Dep. NTIS, $4.00
1159	1:4329	Dep. NTIS, $4.00
1162	1:4278	Dep. NTIS, $4.00
1163	1:4279	Dep. NTIS, $5.00
1178	1:4420	Dep. NTIS, $4.00
1187	1:4330	Dep. NTIS, $4.00

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MERC/SP-		
75/2	1:3001	MERC
75/3	1:4421	Dep. NTIS, $4.00
MHSMP-		
75-5K	1:3539	Dep. NTIS, $4.50
75-12A	1:3621	Dep. NTIS, $5.00
75-24-0	1:3554	Dep. NTIS, $4.50
75-24A	1:3578	Dep. NTIS, $4.50
75-24B	1:3579	Dep. NTIS, $4.50
75-24C	1:3580	Dep. NTIS, $4.50
75-24D	1:3581	Dep. NTIS, $4.50
75-24E	1:3582	Dep. NTIS, $5.00
75-24F	1:3540	Dep. NTIS, $4.50
75-24G	1:3583	Dep. NTIS, $4.50
75-24L	1:3832	Dep. NTIS, $4.50
75-24M	1:3814	Dep. NTIS, $4.50
75-24N	1:3541	Dep. NTIS, $4.50
75-24P	1:3542	Dep. NTIS, $4.50
75-24Q	1:3555	Dep. NTIS, $4.50
75-24R	1:3584	Dep. NTIS, $4.50
75-35	1:3833	Dep. NTIS, $4.50
75-36A	1:3585	Dep. NTIS, $4.50
75-36B	1:3543	Dep. NTIS, $4.50
75-245	1:3544	Dep. NTIS, $4.50
MLM-		
2213	1:3093	Dep. NTIS, $4.00
MRC-SL-		
399	1:3127	*See* SLA-74-0132
MTR-		
6739(Vol.1)	1:3133	Dep. NTIS, $5.75
6739(Vol.2)	1:3134	Dep. NTIS, $10.50
7067	1:3332	TIC
N-		
74-34675	1:3150	NTIS, $5.25
75-16085	1:3115	NTIS, $3.75
75-17406	1:3116	NTIS, $3.25
75-17784	1:3151	NTIS, $3.25
75-18719	1:3152	NTIS, $5.25
75-18720	1:3153	NTIS, $3.25
75-20865	1:3117	NTIS, $3.75
75-20866	1:3118	NTIS, $4.75
75-21794	1:3154	NTIS, $3.25
75-22746	1:3135	NTIS, $3.25
75-22900	1:3119	NTIS, $3.25
75-22903	1:3139	NTIS, $5.75
NASA-Case-MFS-		
22458-1	1:3119	*See* N-75-22900
NASA-Case-NPO-		
13567-1	1:3135	*See* N-75-22746
NASA-CR-		
120623	1:3152	*See* N-75-18719
134740	1:3120	NTIS
140298	1:3150	*See* N-74-34675
141325	1:3121	NTIS
142194	1:3151	*See* N-75-17784
142573	1:3118	*See* N-75-20866
142577	1:3117	*See* N-75-20865
1206060	1:3115	*See* N-75-16085
NASA-TM-X-		
64924	1:3139	*See* N-75-22903
71658	1:3153	*See* N-75-18720
71669	1:3116	*See* N-75-17406
71689	1:3154	*See* N-75-21794
NBSIR-		
75-823	1:3651	Dep. NTIS, $4.75
NP-		
20408	1:3177	Dep. NTIS, $4.00
20578	1:4422	Univ. of North Carolina, Chapel Hill
NSF-OCA-GJ-		
35568X375	1:4423	*See* ORO-3443-53
NSF/RANN/SE/GI-		
37815/PR/74/1	1:3126	*See* PB-235475
NSF/RANN/SE/GI-C-		
937/FR/75/		
1(Vol.1)	1:3132	NTIS, $7.50
937/FR/75/1(		
Vol.2)	1:3131	NTIS, $21.25
NTIS/PS-		
75/347	1:3155	NTIS, $25.00
75/530	1:4094	NTIS, $25.00
NU-		
2512-4	1:3675	Dep. NTIS, $4.50
NUREG-SAND-		
75-0446	1:3660	*See* SAND-75-0446

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NVO-		
153	1:3883	Dep. NTIS, $13.60
165	1:3840	*See* PNE-RB-72
410-30	1:3165	*See* IDO-10062
ORNL-		
4919	1:3180	Dep. NTIS, $5.45
4938	1:3235	Dep. NTIS, $7.60
5000(Pt.2)	1:4081	Dep. NTIS, $10.60
5002	1:3904	Dep. NTIS, $7.60
5062	1:3236	Dep. NTIS, $10.60
5069	1:3012	Dep. NTIS, $5.45
ORNL-HUD-MIUS-		
23	1:3295	Dep. NTIS, $5.45
ORNL-NSF-EATC-		
14	1:3878	Dep. NTIS, $5.45
16	1:3879	Dep. NTIS, $5.45
ORNL-NSF-EP-		
85	1:3358	Dep. NTIS, $4.00
87	1:3315	Dep. NTIS, $5.45
88	1:3359	Dep. NTIS, $5.45
89	1:3320	Dep. NTIS, $5.45
ORNL-RSIC-		
39	1:3240	Dep. NTIS, $4.00
ORNL-RUS-		
6	1:4393	Dep. NTIS, $4.25
ORNL-TM-		
4712	1:3285	Dep. NTIS, $5.45
4758	1:3237	AT
4759	1:3676	Dep. NTIS, $5.45
4843	1:4215	Dep. NTIS, $5.45
4939	1:3260	AT
4957	1:3892	Dep. NTIS, $5.45
4968	1:3026	Dep. NTIS, $7.60
4980	1:3286	AT
4996	1:3261	AT
5007	1:3262	Dep. NTIS, $4.00
5021(Vol.1)	1:3287	Dep. NTIS, $5.45
5021(Vol.2)	1:3288	Dep. NTIS, $5.45
5021(Vol.3)	1:3289	Dep. NTIS, $5.45
5021(Vol.4)	1:3290	Dep. NTIS, $4.00
5025	1:3264	Dep. NTIS, $4.00
5027	1:3384	AT
5042	1:4313	Dep. NTIS, $7.60
5088	1:4183	Dep. NTIS, $4.00
5092	1:3002	Dep. NTIS, $4.00
5124	1:3003	Dep. NTIS, $4.00
5126	1:3291	Dep. NTIS, $5.45
5153	1:4257	Dep. NTIS, $5.45
5157	1:3815	Dep. NTIS, $4.00
5158	1:4280	Dep. NTIS, $4.00
ORNL-tr-		
2919	1:3685	Dep. NTIS, $4.00
2924	1:3820	Dep. NTIS, $5.00
2930	1:3898	Dep. NTIS, $4.00
2931(RD)	1:3884	Dep. NTIS, $4.00
2935	1:3899	Dep. NTIS, $4.00
2950	1:3905	Dep. NTIS, $4.50
2955	1:3599	Dep. NTIS, $4.50
2961	1:3900	Dep. NTIS, $4.00
2975	1:4032	Dep. NTIS, $4.00
2982	1:3880	Dep. NTIS, $4.00
4015	1:3686	Dep. NTIS, $4.00
4023	1:3182	Dep. NTIS, $5.75
4026	1:3679	Dep. NTIS, $4.00
4029	1:4281	Dep. NTIS, $4.50
4033	1:3217	Dep. NTIS, $5.00
4038	1:3412	Dep. NTIS, $4.50
4043	1:3414	Dep. NTIS, $4.50
4053	1:4095	Dep. NTIS, $4.50
ORO-		
3443-53	1:4423	Dep. NTIS, $5.50
3443-55	1:4130	Dep. NTIS, $4.50
3817-4	1:4424	Dep. NTIS, $11.25
4002-4	1:4056	Dep. NTIS, $5.00
4183-22	1:3607	Dep. NTIS, $4.50
4310-4	1:3912	Dep. NTIS, $4.00
4398-3	1:3316	Dep. NTIS, $11.75
4447-029	1:3614	Dep. NTIS, $6.25
PATENTS-US-		
3,874,452	1:3049	
3,880,238	1:3050	
3,881,550	1:3052	
3,881,551	1:3051	
3,884,715	1:3296	
3,884,829	1:3054	

Report No.	Abstract No.	Availibility
3,887,453	1:3055	
3,888,307	1:3053	
3,888,543	1:3048	
3,891,550	1:3056	
3,900,430	1:3047	
3,902,436	1:3718	
3,905,196	1:3170	
PB-		
231115	1:3125	NTIS, $6.75
235424	1:3141	NTIS, $8.00
235428	1:3142	NTIS, $8.25
235432	1:3143	NTIS, $9.75
235433	1:3144	NTIS, $8.00
235475	1:3126	NTIS, $7.00
235483	1:3145	NTIS, $3.75
PEL-		
246	1:3864	Dep. NTIS (US Sales Only), $4.50
PERC/RI-		
75/4	1:3030	Dep. NTIS, $4.00
PNE-RB-		
72	1:3840	Dep. NTIS, $5.50
RDT-M-		
4-4T(10-75)	1:3409	RSO
5-8T(10-75)	1:3385	RSO
RDT-P-		
2-5T(Rev.)(10-75)	1:3232	RSO
REG/G-		
1.107	1:3231	NUREG
RFP-Trans-		
167	1:3550	Dep. NTIS, $4.00
RISO-		
285	1:3844	Dep. NTIS (US Sales Only), $8.25
RISO-M-		
1759	1:3178	Dep. NTIS (US Sales Only), $8.75
RL-		
75-116	1:4425	Dep. NTIS (US Sales Only), $4.00
RT/FI-		
(75)9	1:4426	Dep. NTIS (US Sales Only), $4.50
RT/PROT-		
(75)11	1:4053	Dep. NTIS (US Sales Only), $6.00
SAND-		
74-0448	1:3702	Dep. NTIS, $7.25
74-5281	1:4427	Dep. NTIS, $5.25
74-7013	1:3484	Dep. NTIS, $4.75
75-0038	1:4428	Dep. NTIS, $5.00
75-0147	1:4429	Dep. NTIS, $5.00
75-0148	1:4430	Dep. NTIS, $4.00
75-0149	1:4431	Dep. NTIS, $4.00
75-0150	1:4478	Dep. NTIS, $4.00
75-0151	1:4432	Dep. NTIS, $4.00
75-0152	1:4433	Dep. NTIS, $4.50
75-0175	1:3873	Dep. NTIS, $4.00
75-0217	1:4099	Dep. NTIS, $5.50
75-0281	1:3703	Dep. NTIS, $4.50
75-0287	1:3665	Dep. NTIS, $4.00
75-0358	1:3156	Dep. NTIS, $4.50
75-0360	1:3693	Dep. NTIS, $5.45
75-0388	1:3112	Dep. NTIS, $4.00
75-0411	1:3506	Dep. NTIS, $5.50
75-0416	1:3677	Dep. NTIS, $5.00
75-0420	1:4179	Dep. NTIS, $5.45
75-0428	1:4434	Dep. NTIS, $4.00
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75-0450	1:4435	Dep. NTIS, $4.00
75-0467	1:3705	Dep. NTIS, $4.00
75-0471	1:3013	Dep. NTIS, $4.00
75-0473	1:3507	Dep. NTIS, $4.00
75-0475	1:3706	Dep. NTIS, $4.00
75-0501	1:3638	Dep. NTIS, $5.45
75-0538	1:3533	Dep. NTIS, $4.50
75-0539	1:4436	Dep. NTIS, $5.00
75-5218	1:4437	Dep. NTIS, $4.00
75-5272	1:3146	Dep. NTIS, $4.50
75-5393	1:4378	Dep. NTIS, $4.00
75-5415	1:4246	Dep. NTIS, $4.50
75-5425	1:3707	Dep. NTIS, $4.00
75-5437	1:4379	Dep. NTIS, $4.00
75-5455	1:3708	Dep. NTIS, $4.00
75-5490	1:4100	Dep. NTIS, $4.00
75-5502	1:3639	Dep. NTIS, $4.50
75-5512	1:3176	Dep. NTIS, $4.00
75-5520	1:4380	Dep. NTIS, $4.00
75-5672	1:3040	Dep. NTIS, $4.00
75-5684	1:3241	Dep. NTIS, $4.00
75-5691	1:4350	Dep. NTIS, $4.00
75-5731	1:3802	Dep. NTIS, $4.50
75-5751	1:4351	Dep. NTIS, $4.50
75-5765	1:4352	Dep. NTIS, $5.00
75-5802	1:4381	Dep. NTIS, $5.00
75-5803	1:4353	Dep. NTIS, $5.00
75-5807	1:3427	Dep. NTIS, $4.50
75-5973	1:4438	Dep. NTIS, $4.50
75-5987	1:3292	Dep. NTIS, $4.50
75-6008	1:4020	Dep. NTIS, $4.50
75-6062	1:4439	Dep. NTIS, $4.50
75-6092	1:3709	Dep. NTIS, $4.50
75-8043	1:4440	Dep. NTIS, $4.75
75-8053	1:3710	Dep. NTIS, $4.50
-75-8261	1:3816	Dep. NTIS, $4.50
75-8281	1:4441	Dep. NTIS, $7.50
75-8653	1:4344	Dep. NTIS, $4.50
SC-RR-		
64-605	1:3448	Dep. NTIS, $4.75
SGAE-		
2408	1:4442	Dep. NTIS (US Sales Only), $5.50
SIT-		
291	1:4299	*See* COO-3004-11
SLA-		
74-0114	1:3410	Dep. NTIS, $5.25
74-0132	1:3127	Dep. NTIS, $6.75
SLAC-PUB-		
1650	1:4150	Dep. NTIS, $4.50
SLL-		
73-0287	1:3534	Dep. NTIS, $5.00
SM-		
199/60	1:4091	*See* BNWL-SA-5389
201/84	1:3090	*See* HEDL-SA-950
202/218	1:4059	*See* COO-3017-24
SN-		
566493	1:3135	*See* N-75-22746
671458	1:3119	*See* N-75-22900
SRIA-		
37(Add.)	1:3512	Dep. NTIS, $4.50
SSI-		
1974-028	1:4041	Dep. NTIS (US Sales Only), $4.25
1974-032	1:4057	Dep. NTIS (US Sales Only), $4.00
STAN-CS-		
75-496	1:4443	Dep. NTIS, $10.00
SU-		
326P30-41	1:4443	*See* STAN-CS-75-496
326-P30-43	1:4444	Dep. NTIS, $4.00
TID-		
3557-S10	1:4207	Dep. NTIS, $13.60
26868	1:3094	Dep. NTIS, $7.50
26879	1:3122	Dep. NTIS, $4.50
26885	1:4445	Dep. NTIS, $7.00
26889	1:3893	Dep. NTIS, $6.00
UCCND-CSD-		
18	1:4446	Dep. NTIS, $5.45
21	1:4447	Dep. NTIS, $7.60
24	1:4448	Dep. NTIS, $4.00
UCCND-CSD-INF-		
58	1:4122	Dep. NTIS, $4.00
64	1:3865	Dep. NTIS, $4.00
UCD-		
34P-200X2	1:3964	Dep. NTIS, $4.00
UCID-		
3711	1:3323	Dep. NTIS, $5.00
3724	1:3345	Dep. NTIS, $6.00
3731	1:3352	Dep. NTIS, $4.50
3734	1:3346	Dep. NTIS, $4.50
3735	1:3317	Dep. NTIS, $5.00
3760	1:3318	Dep. NTIS, $6.50
3771	1:3360	Dep. NTIS, $5.00
3772	1:3361	Dep. NTIS, $4.50
3773	1:3362	Dep. NTIS, $4.50
3774	1:3363	Dep. NTIS, $4.50
3775	1:3364	Dep. NTIS, $4.50
3776	1:3365	Dep. NTIS, $4.50

Report No.	Abstract No.	Availibility
16776	1:4303	Dep. NTIS, $4.00
16880	1:3831	Dep. NTIS, $7.60
16899	1:4449	Dep. NTIS, $4.00
16914	1:4216	Dep. NTIS, $4.50
16915	1:4450	Dep. NTIS, $5.45
16918	1:3640	Dep. NTIS, $4.50
16919	1:4451	Dep. NTIS, $4.50
16924	1:4202	Dep. NTIS, $4.50
16931	1:3666	Dep. NTIS, $4.50
16939	1:4247	Dep. NTIS, $5.50
16944	1:4254	Dep. NTIS, $4.50
16945	1:3803	Dep. NTIS, $5.00
16947	1:4258	Dep. NTIS, $4.00
16953	1:3834	Dep. NTIS, $4.50
30098(Rev.1)	1:4452	Dep. NTIS, $5.45
30113(Pt.1)	1:4453	Dep. NTIS, $4.50
30113(Pt.2)	1:4454	Dep. NTIS, $4.50
30115	1:4455	Dep. NTIS, $5.00
30119	1:4456	Dep. NTIS, $4.00
30121	1:4457	Dep. NTIS, $4.50
30122	1:4458	Dep. NTIS, $4.00
UCRL-		
13021(Add.)	1:3512	*See* SRIA-37(Add.)
13661	1:3386	Dep. NTIS, $4.50
13662	1:3837	Dep. NTIS, $6.00
50026-75-2	1:3014	Dep. NTIS, $4.00
50026-75-3	1:3015	Dep. NTIS, $4.00
51694(Rev.2)	1:4459	Dep. NTIS, $4.00
51797	1:4314	Dep. NTIS, $7.60
51820	1:4259	Dep. NTIS, $5.45
51829	1:4460	Dep. NTIS, $10.60
51869	1:3449	Dep. NTIS, $4.00
51872	1:4382	Dep. NTIS, $5.45
51877	1:3678	Dep. NTIS, $4.00
51878	1:4461	Dep. NTIS, $4.00
51885	1:3508	Dep. NTIS, $4.00
51890	1:3347	Dep. NTIS, $4.00
51893	1:4116	Dep. NTIS, $7.60
51901	1:3838	Dep. NTIS, $4.00
51904	1:3016	Dep. NTIS, $4.00
51909	1:3017	Dep. NTIS, $4.00
51910	1:3058	Dep. NTIS, $4.00
51940	1:4462	Dep. NTIS, $5.00
51946	1:4304	Dep. NTIS, $5.45
52000-75-8	1:3168	Dep. NTIS, $4.00
52000-75-9	1:3302	Dep. NTIS, $4.00
76125	1:3641	Dep. NTIS, $4.00
76542(Rev.1)	1:4463	Dep. NTIS, $5.50
76573	1:4354	Dep. NTIS, $5.00
76590	1:3804	Dep. NTIS, $4.50
76706	1:4335	Dep. NTIS, $4.00
76707	1:4336	Dep. NTIS, $4.00
76708	1:3615	Dep. NTIS, $4.00
76734	1:4345	Dep. NTIS, $4.00
76761	1:4383	Dep. NTIS, $4.00
76765	1:4384	Dep. NTIS, $4.00
76794	1:3179	Dep. NTIS, $4.00
76835	1:4464	Dep. NTIS, $4.00
76911	1:4346	Dep. NTIS, $4.00
76912	1:3348	Dep. NTIS, $4.50
76924	1:3519	Dep. NTIS, $4.00
77057	1:4355	Dep. NTIS, $4.00
77115	1:4098	Dep. NTIS, $4.00
77123	1:3913	Dep. NTIS, $4.00
77152	1:4217	Dep. NTIS, $4.50
77203	1:3667	Dep. NTIS, $4.50
77207	1:3954	Dep. NTIS, $4.50
77213	1:3668	Dep. NTIS, $8.00
77229	1:4331	Dep. NTIS, $4.50
77237	1:4347	Dep. NTIS, $4.50
77240	1:4385	Dep. NTIS, $4.50
77245	1:4315	Dep. NTIS, $4.50
77263	1:4386	Dep. NTIS, $4.50
77279	1:4465	Dep. NTIS, $4.00
77285	1:4466	Dep. NTIS, $4.50
77295	1:3387	Dep. NTIS, $4.00
77303	1:3039	Dep. NTIS, $5.00
77350	1:3642	Dep. NTIS, $4.00
77352	1:3643	Dep. NTIS, $4.00
77357	1:4387	Dep. NTIS, $5.50
77371	1:3247	Dep. NTIS, $4.25
77388	1:3684	Dep. NTIS, $4.00
77414(Rev.1)	1:4467	Dep. NTIS, $4.50
77429	1:3835	Dep. NTIS, $4.50
77446	1:3817	Dep. NTIS, $4.50
77447	1:4468	Dep. NTIS, $4.50
77448	1:3711	Dep. NTIS, $4.50
UCRL-Trans-		
10721	1:3174	Dep. NTIS, $5.50
10729	1:3646	Dep. NTIS, $4.50
10730	1:3682	Dep. NTIS, $5.00
10731	1:3836	Dep. NTIS, $4.00
10732	1:3549	Dep. NTIS, $4.00
10842	1:3163	Dep. NTIS, $7.50
10920	1:3451	Dep. NTIS, $4.50
10921	1:3031	Dep. NTIS, $4.50
10922	1:3020	Dep. NTIS, $4.50
10924	1:3712	Dep. NTIS, $4.50
10925	1:3819	Dep. NTIS, $5.00
10926	1:3370	Dep. NTIS, $4.50
10933	1:3019	Dep. NTIS, $5.00
10935	1:4298	Dep. NTIS, $4.50
10936	1:3547	Dep. NTIS, $5.00
10937	1:3546	Dep. NTIS, $4.50
10938(Pt.1-2)	1:3501	Dep. NTIS, $5.00
10939	1:3598	Dep. NTIS, $4.50
10942	1:4363	Dep. NTIS, $4.50
10943	1:3450	Dep. NTIS, $4.50
10945	1:4203	Dep. NTIS, $4.50
10947	1:3535	Dep. NTIS, $4.50
10948	1:3576	Dep. NTIS, $4.50
10949	1:3681	Dep. NTIS, $5.00
10952	1:3028	Dep. NTIS, $4.50
10953	1:3033	Dep. NTIS, $4.50
10954	1:4242	Dep. NTIS, $4.50
10956	1:3032	Dep. NTIS, $4.50
10957	1:3022	Dep. NTIS, $4.50
10958	1:3021	Dep. NTIS, $5.00
UIUCDCS-R-		
75-754	1:4404	*See* COO-2383-0025
UNI-		
436	1:3265	Dep. NTIS, $5.50
USC-		
133P19-92	1:4469	Dep. NTIS, $5.00
USGS-		
474-206	1:3886	Dep. NTIS, $5.45
474-220	1:3887	Dep. NTIS, $5.45
UVA-ER-		
001-75U	1:3616	Dep. NTIS, $6.25
WARD-HT-		
3045-9	1:3411	AT
Y-		
1997	1:3644	Dep. NTIS, $4.00
2002	1:3818	Dep. NTIS, $4.00
Y-DA-		
6375	1:3645	Dep. NTIS, $4.50
Y-OA-		
1545	1:3388	Dep. NTIS, $4.00
ZJE-		
166	1:3867	Dep. NTIS (US Sales Only), $4.50
167	1:3868	Dep. NTIS (US Sales Only), $4.00

Abbreviations Used in Availability Column

AT Liquid Metal Fast Breeder Reactor applied technology is available to domestic requesters within the United States from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, TN 37830.
Information regarding subscription purchase will be sent on request.
Foreign requesters should address inquiries to the above address.

Dep. ERDA reports so designated are maintained in the organizations listed on the inside front cover.

EM Inquiries regarding the availability of blueline prints of ERDA engineering drawings which were formerly available for sale by NTIS should be addressed to USERDA, Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.

GJO Available from USERDA, Grand Junction Office, P. O. Box 2567, Grand Junction, Colorado 81501.

GPO For sale by the Superintendent of Documents, Government Printing Office, Washington, D. C. 20402.

LMEC Available *only to requesters within the United States* from the Liquid Metal Engineering Center, P. O. Box 1449, Canoga Park, CA 91304.

NTIS For sale by the National Technical Information Service (NTIS), U. S. Department of Commerce, Springfield, Virginia 22161. Price given is the domestic price for paper copy; foreign purchasers add $2.50 per report copy.

RSO Available *only to requesters within the United States* from the Reactor Standards Office, Oak Ridge National Laboratory, P. O. Box X, Oak Ridge, TN 37830.

TIC Available from the USERDA Technical Information Center, P. O. Box 62, Oak Ridge, Tennessee 37830.